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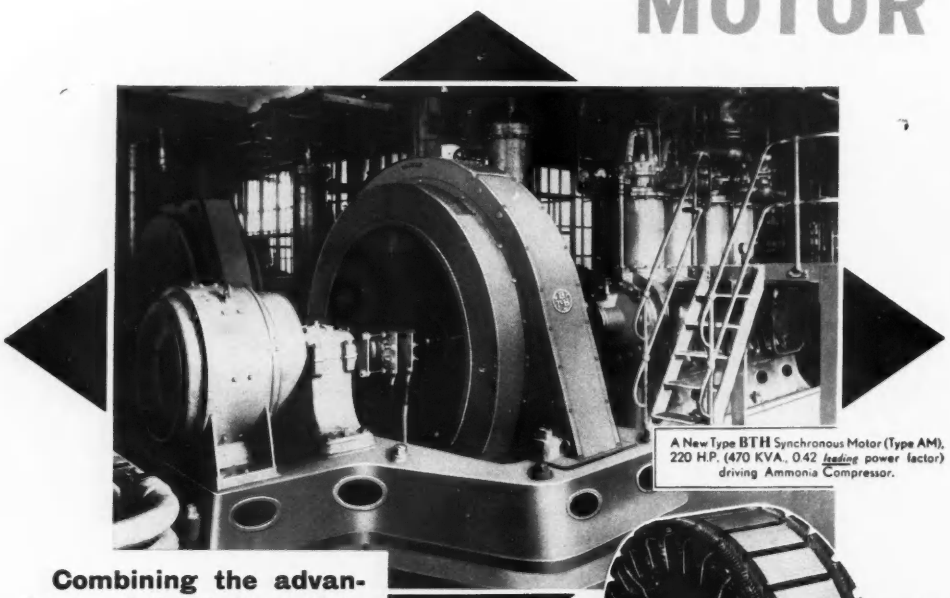
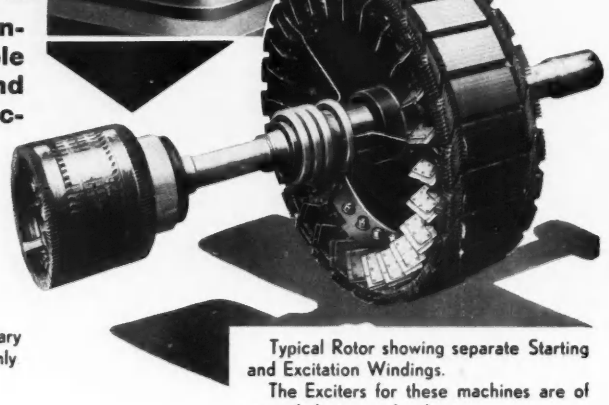
B T-H

New type of SYNCHRONOUS MOTOR



A New Type BTH Synchronous Motor (Type AM), 220 H.P. (470 KVA., 0.42 *leading* power factor) driving Ammonia Compressor.

Combining the advantages of the Salient Pole Synchronous Motor and the Synchronous Induction Motor.



Typical Rotor showing separate Starting and Excitation Windings.
The Exciters for these machines are of normal design and voltage.

Starts—

under load without shock using ordinary rotor starter and excitation switch only

Runs—

at highest efficiency and any desired power factor (unity or leading).

For Anything Electrical
CONSULT BTH

BTH RUGBY

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, RUGBY, ENGLAND

A Seven-Day Journal

The Unemployment Figures.

ACCORDING to a statement issued by the Ministry of Labour on Monday, April 8th, it is estimated that at March 25th, 1935, there were approximately 10,200,000 insured persons aged sixteen to sixty-four in employment in Great Britain. This was 119,000 more than a month before and 139,000 more than a year before. In nearly all the principal industries there was an improvement in employment between February 25th and March 25th. The most marked improvement occurred in the building industry, but there were also substantial reductions in the numbers unemployed in public works contracting, coal mining, engineering, iron and steel manufacture, the tailoring, cotton, pottery and motor vehicle industries, the transport and distributive trades, and hotel, boarding-house services. In none of the principal industries was there a marked decline in employment. At March 25th, 1935, the numbers of unemployed persons on the registers of employment exchanges in Great Britain were 1,746,277 wholly unemployed, 317,910 temporarily stopped, and 89,683 normally in casual employment, making a total of 2,153,870. This was 131,593 less than the number on the registers at February 25th, 1935, and 47,707 less than a year before. The total on March 25th, 1935, comprised 1,707,469 men, 61,308 boys, 328,874 women, and 56,219 girls.

The New Science Museum.

IN the course of his reply to a question put in the House of Commons on Tuesday evening, April 9th on the request of the Royal Commissioners for the Exhibition of 1851 to be released from their undertaking to contribute to the cost of the new Science Museum, Mr. Neville Chamberlain, the Chancellor of the Exchequer, said that the Commissioners had represented to his Majesty's Government that any curtailment of their educational programme would be extremely unfortunate, and that indeed its further extension to the limit of their existing resources would be fully justified. In this view he concurred, and he had, therefore, decided that it would be in the public interest that the Commissioners should be relieved of their liability to contribute further to the cost of the Museum. Mr. Chamberlain pointed out that the Royal Commissioners for the Exhibition of 1851, being empowered under their Supplemental Charter to utilise the surplus funds arising from the Exhibition to promote the knowledge of science and art and their application in productive industry, offered in 1876 to contribute towards the cost of building a science museum on the Commissioners' estate in South Kensington. That offer was not accepted by the Government until 1910, and, owing to the intervention of the war period, the first section of the Museum, to the cost of which the Commissioners had duly contributed their share, had only just been completed. During the interval the Commissioners began to use their income for the provision of scholarships and bursaries, which extended to the Dominions as well as to this country, and the development of their schemes in this connection had proved to be of quite exceptional importance and value.

Motor Unit for Colonial Use.

IN THE ENGINEER of July 21st, 1933, a full description was given of the Hardy Southall tractor unit constructed for the Overseas Transport Directing Committee. It was the second of its kind to be built, the first being a petrol-engined unit which was sold to the Gold Coast Government. This unit was equipped with a 130 h.p. A.E.C. heavy oil engine, and it has now just completed 9937 miles of test running in different parts of Australia. During the trials, which lasted twenty-nine weeks, the fuel consumption averaged 3·15 miles per gallon, or 47 ton-miles per gallon, and the speed 12·80 miles per hour at full load. When lightly loaded on return journeys distances up to 170 miles a day could be covered at an average speed of 17·45 miles per hour, the fuel consumption being under these conditions 4·5 miles per gallon. The running cost has worked out at 3·70d. per net ton mile, assuming an economical life of 100,000 miles and interest on capital at 4 per cent. This figure forms an interesting comparison with the normal ruling charges for orthodox motor transportation in the Northern Territory, which range from 9d. to 1s. 6d. per ton mile. On outward journeys the unit was normally fully loaded, sometimes even loaded to its maximum capacity of 20 tons, but return freights were hard to come by, so that the average return load was only 8·72 tons. Losses of time were also experienced owing to the lack of loading and unloading facilities. Difficulty was experienced from the fact that the well-known Colonial driving method of "riding the ruts" could not be followed out, owing to the large track of the unit. The Committee now feels that a 30-ton unit could be run at a considerably greater economy, and that a 4½-ton axle load would be no bar to the extended use of such a vehicle, nor would it involve a greater deterioration of road surface than that produced by the ordinary 4-tonner in general use. The abilities of such a means of transport to open up large tracts of country wherever railways are not a paying proposition are now proved. Unfortunately, the funds available are practically exhausted, and will not permit the development of such a vehicle unless supplementary funds are forthcoming.

Engineers' Wages.

AT a joint meeting held in London on Thursday of last week, April 4th, the two committees representing the Engineering and Allied Employers' National Federation and the Engineering Trade Unions agreed mutually that the war bonus shall be increased by 2s. per week to all adult male workers. The increase will apply as follows :—1s. per week as from Monday, May 13th, and an additional shilling as from Monday, July 15th. It may be recalled that last month the Engineering and Allied Employers' National Federation refused the claims of the unions for an all-round increase of 2d. an hour, with an equivalent advance to pieceworkers and the revision of the 1931 agreement on piecework, night shift, overtime, and coupling-up rates, and reversion to the rates and conditions, including piecework, in operation prior to the 1931 agreement. At the conference, on the suggestion of the Federation, the two committees above mentioned were appointed to explore the situation further to see if an arrangement capable of mutual recommendation could be found. The trade union officials who have been engaged in the protracted negotiations have since expressed themselves as fairly well satisfied with the concession offered by the employers. At last month's joint meeting Mr. Alexander Ramsay, speaking for the Federation, pointed out that while the engineering industry had shown a considerable improvement since last year, there were numerous sections of it which were still quite definitely suffering from slump conditions.

Great Britain's Airways.

A LETTER on the future organisation of the internal airways of Great Britain has been addressed to the Secretary of State for Air by the Commercial Aviation Committee of the London Chamber of Commerce, of which Committee Sir Stephen Demetriadi is the Chairman. In the letter the Commitee states that it has considered various resolutions on the matter, and was impressed in each case with the importance attached to the necessity for setting up a Central Authority with statutory powers. This authority should have charge of the planning of internal airway organisation, and upon it Government Departments concerned, air transport operators, and insurance and commercial interests should be represented. The Committee adds that it understands that a scheme has been adopted in India whereby the equivalent of the amount of the tax levied on petrol used in aircraft is credited to a special fund and handed over to the Director of Civil Aviation in addition to the ordinary Government grant. After pointing out that there may be some objection in this country to the principle of the financing of a central authority in the manner adopted in India, the Committee states that it has submitted for the consideration of the Government that an annual grant should be made from Government funds to the proposed central authority towards the provision of the necessary airway organisation. Such a grant, it is suggested, should be reviewed from time to time, and should have some regard to the computed yield from the tax on petrol used for the purposes of flying within the limits of the British Isles.

Noteworthy Launches.

IN to-day's issue we give some account of the launch of the new P. and O. liner "Strathmore" at Barrow-in-Furness on Thursday, April 4th. That day was also marked by the launches of two other noteworthy ships. On the Tyne there was launched from the Neptune Shipyard of Swan, Hunter and Wigham Richardson, Ltd., the motor vessel "Duntroon," which has been constructed for the Melbourne Steamship Company, Ltd., to meet the increasing requirements of the passenger service between the important seaports on the coast of Australia. The ship is 470ft. in length and 65½ft. in breadth, and has a deadweight carrying capacity of about 6000 tons, with a contract speed of 16½ knots. There are five cargo holds for the carriage of general cargo, and seven cargo between-deck compartments. The deck machinery and arrangements, designed for the rapid and efficient handling of cargo, are of the most modern kind. There is accommodation for 266 first saloon passengers and 107 second saloon passengers. The propelling machinery, which is being installed by Swan, Hunter and Wigham Richardson, consists of twin-screw Kincaid-B. and W. oil engines. At the yard of the Ardrossan Dockyard Company, there was also launched on April 4th Britain's largest motor coasting vessel, which is being built for the London-Liverpool service of Coast Lines, Ltd. She has a length of 250ft., with a beam of 38ft., and her propelling machinery comprises a twin-screw arrangement of British Polar Atlas oil engines, with a designed output of 1450 s.h.p. With a deadweight cargo of 1600 tons, the new vessel is to have a service speed of about 12 knots. After the launch luncheon a letter was read from Sir John Sandeman Allen, the Chairman of the Coastal Trade Development Council, which recorded a steady, increasing appreciation in industrial and municipal circles of the value of coastal shipping to the trade and industry of the country.

The Hawsewater Scheme.

ON Friday, April 5th, the members of the Manchester Waterworks Committee visited Hawsewater and laid a foundation stone in the base of the dam, which, when completed, will impound the waters of Mardale, which will then flow southward through the Long Sleddale tunnel, now practically complete, and join the Thirlmere aqueduct. It will be recalled that the work on the Hawsewater scheme was suspended for about three years and that a year ago the Manchester authorities decided to prepare the ground for a smaller dam than that which was originally planned. On Wednesday last week, the Manchester City Council authorised the Waterworks Committee to complete the original proposals, which will raise the water of the lake 100ft. and increase its length from 2½ miles to about 4¼ miles, ensuring a plentiful supply of water to Manchester and all the authorities of South-East Lancashire who may wish to buy it. The foundation stone was laid on the rock formation of blue Andesite, upon which the dam is to be constructed. It is a 30 cwt. block of polished pink shap stone, placed on the line of the forward slope of the dam. A quarry is being opened in Naddle Forest from which all the stone needed for the dam will be obtained. The foundation stone of a new hotel which will replace the Dun Bull was also laid by Sir William Kay, Deputy Chairman of the Waterworks Committee, and an original promoter of the Haweswater scheme.

Palmers Hebburn.

IN a Journal note of November 30th, 1934, we recorded the registration of a private company styled Palmers Hebburn Company, which was formed to take over the ship and engine-repairing and constructional steel work interests of the late Palmers' Shipbuilding and Iron Company, Ltd., at Hebburn-on-Tyne. The Chairman of the company was Mr. F. C. Pyman and its managing director Mr. E. L. Champness. On Thursday, April 4th, when speaking at the launch of the new P. & O. liner "Strathmore," at Barrow-in-Furness, Sir Charles Craven announced that within the last few days Vickers, Armstrongs, Ltd., had purchased the ship-repairing and dry-dock interests of Palmers Hebburn, and hoped to do something to relieve unemployment on the North-East Coast. It is understood that the purchase by Vickers, Armstrongs, Ltd., of the share interest in the company will not involve any change in the name of the undertaking, but that the present board will probably be strengthened by the addition of Sir Charles Craven and one or two others. The business will be carried on by the present management and staff, and we are given to understand that some improvements in the yard and its equipment are projected and that they are likely to be carried out in due course.

Industry in Canada.

ON Tuesday, April 9th, the report of the Royal Commission on Wages, Price Spreads, and Industrial Conditions in Canada, was published in Ottawa. Among other proposals for the regulation of commerce, industry, and finance, the following are made :—The establishment of a Federal Trade and Industry Commission, consisting of five members appointed by the Cabinet, to supervise generally, or co-operate in the administration of the existing laws relating to trading and business practices, for which no other agency exists. It is also proposed to create a Consumer Commodity Standards Board as a section of the Commission, to establish consumers' standards and specifications and to enforce such standards, and to set up a new division in the Federal Department of Labour for general research into industrial conditions. A further proposal is for the national regulation of employment conditions, preferably by Federal legislation, or alternatively by co-operation between the Provinces. It is also suggested that the standard hours of labour should be reduced to a level not exceeding forty-four hours a week, but that this reduction should be accompanied by a certain flexibility in the administration of such laws to permit longer hours when necessary, with payment for overtime. A more complete organisation of employers' associations and workers' unions is suggested by the Commissioners together with certain other proposals which would affect company law and procedure and influence the marketing of livestock intended for export.

The Development of Parsons Industrial Turbo Machinery.

No. XIV.

(*Concluded from page 350, April 5th.*)

Side-by-Side Geared Turbine Driving Alternator and Jute Mill.

ANOTHER application of the side-by-side geared turbine, illustrating the versatility of the type, is shown by the photograph reproduced in Fig. 127. This represents a plant constructed in 1928 by Messrs. Parsons for the Belvedere Jute Mill in India. The turbine has a normal capacity of 5000 b.h.p., but outputs up to 6250 b.h.p. can be developed by means of the by-pass valve. The high-pressure and the low-pressure portions of the turbine both run at 4500 r.p.m., and drive the central gear wheel at 300 revolutions. To one side of this wheel is coupled the main shaft of the mill, which is extended through the engine-room wall to the rope race, where it carries the main driving pulley of the mill. A second shaft coupled to the other side of the gear wheel passes between the two cylinders of the turbine and drives an alternator in the engine-room.

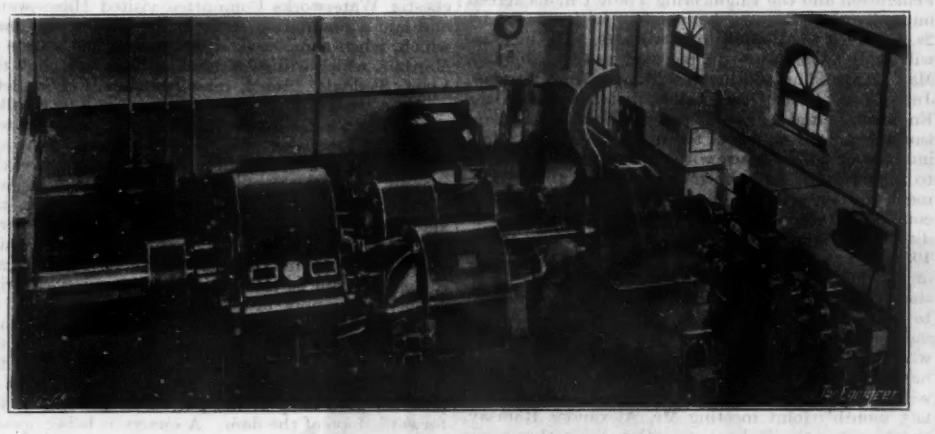


FIG. 127—5000 B.H.P. SIDE-BY-SIDE GEARED TURBINE FOR JUTE MILL—1928

The arrangement was not altogether new at the time, as a number of turbines had been supplied previously for driving a rope pulley from one side of the central gear wheel and an alternator from the other, but the earlier machines were of smaller capacity than that illustrated, their outputs being generally from 2000 to 3500 b.h.p.

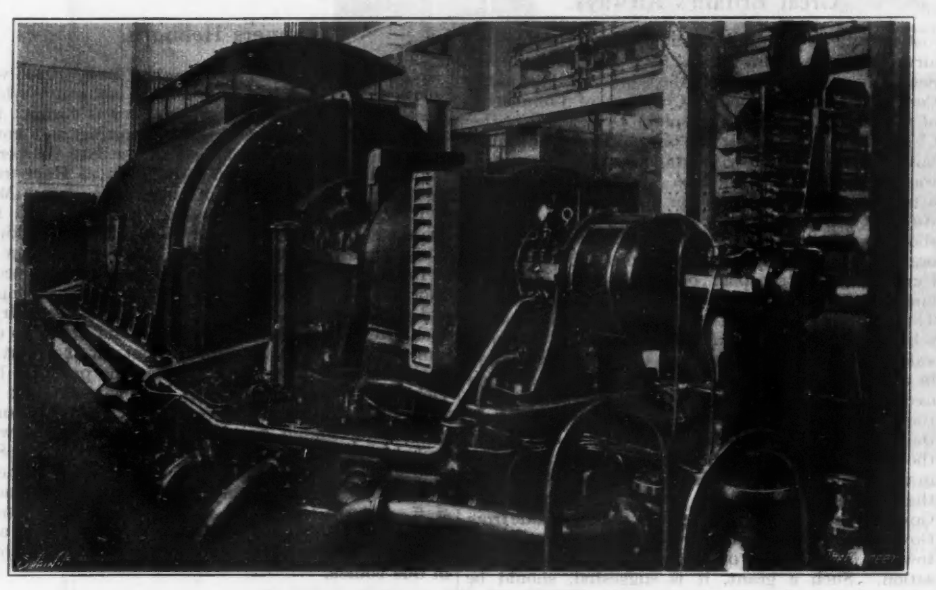


FIG. 128—1,500,000 KVA SHORT-CIRCUIT TESTING PLANT—1929

1,500,000-kVA Short-Circuit Testing Alternator.

Among the great variety of electrical plant constructed for industrial purposes by Messrs. Parsons, two machines stand out as unique by reason of their special characteristics. These are a pair of alternators of the high-speed turbo type supplied to A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne, for the equipment of their high-powered switchgear testing station. Each of the machines is capable of developing a short-circuit output as great as 1,500,000 kVA, at pressures of either 6350, 11,000, 12,700, or 22,000 volts, as may be desired at the terminals of the machine. The first of these alternators was ordered in 1929. As no such machine had ever been attempted before, the first idea of Messrs. Reyrolle was to equip their testing plant with two smaller units which could be operated in parallel, but after an exhaustive examination of the whole problem, in which the late Sir Charles Parsons was keenly interested, it was decided to accept the offer of the Heaton

FIG. 130—END VIEW OF STATOR OF SHORT-CIRCUIT TESTING PLANT

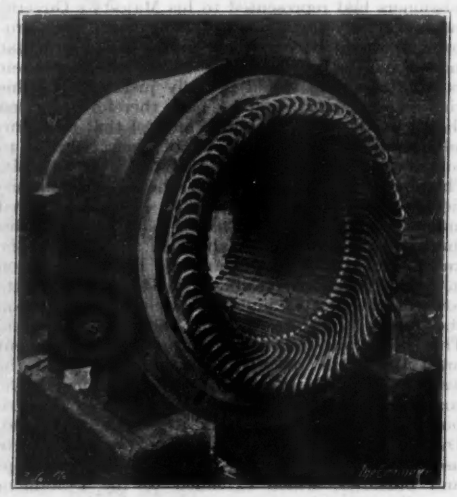


FIG. 131—STATOR OF DYNAMOMETER

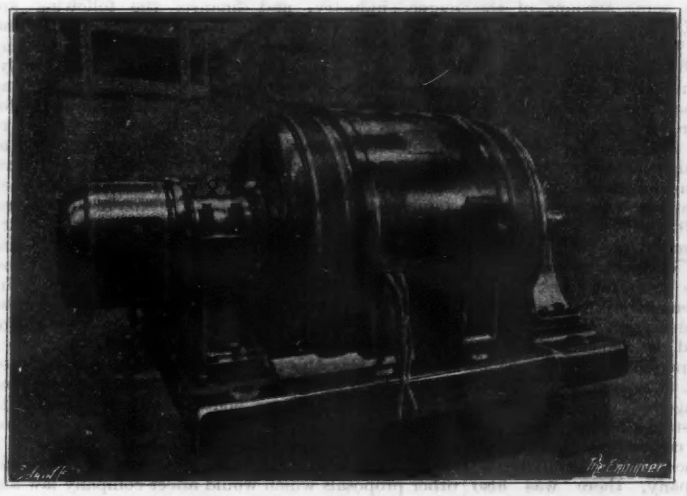


FIG. 129—ELECTRICAL DYNAMOMETER FOR TESTING AERO ENGINES—1930

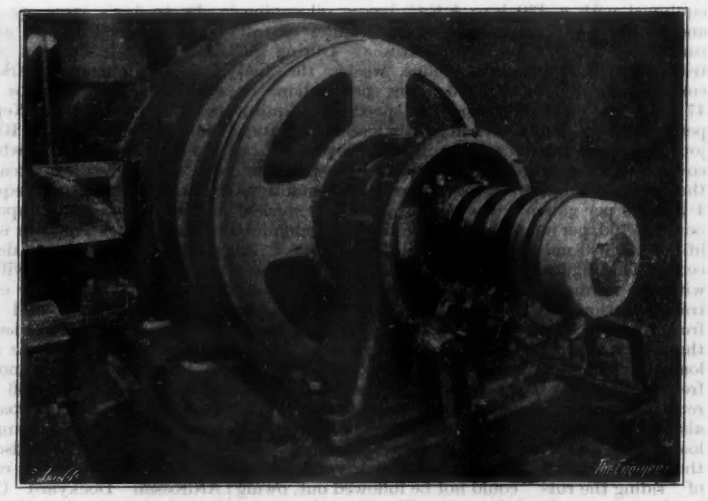


FIG. 132—DYNAMOMETER WITH SLIP-RING COVER REMOVED

Works to provide the required output of 1,500,000 kVA in a single machine. The set in question was driven by a 1200 h.p. induction motor at 240 r.p.m. from the 40-cycle mains of the local power company. The second unit, ordered in 1932, takes power from the 50-cycle system, and runs at 3000 r.p.m. Each alternator, with its driving motor and bed plate, weighs about 120 tons, and is strongly bolted down to a concrete foundation weighing another 250 tons.

In view of their particular duties, namely, to pro-

FIG. 133—EXPERIMENTAL 250-KW "UNIPLANE" SET—1929

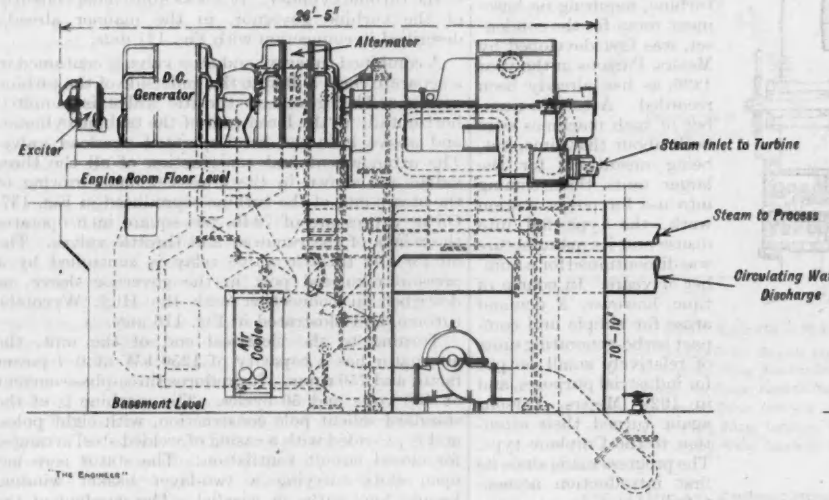
duce short-circuit currents equal to those to which the largest power station switchgear could be subjected, and to withstand an indefinite number of dead short circuits across their own terminals when running at full speed and voltage, the design of the alternators is of great interest. The reactance of the windings was kept very low—only about 2 per cent.—in order not to limit the short-circuit current, and the moment of inertia of the running mass was made as great as possible, so that the maximum energy should be available for the tests. The kinetic energy stored in each set when running is equal to that of a number of smaller generators working in parallel and capable of the same total kVA output on short circuit. Furthermore, in order that the Reyrolle alternators should enable switchgear to be tested under conditions similar to those obtaining in the event of a short circuit of a power station, heavy damping bars were fitted to the rotors with the object of ensuring a short-circuit decrement characteristic identical with that of a modern generating plant.

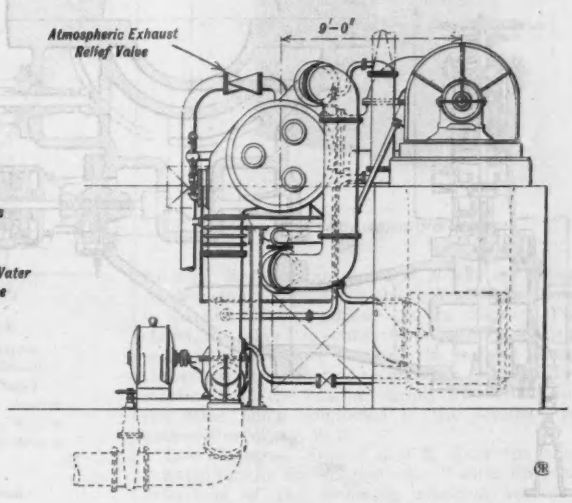
The stator frame of each alternator is built up of welded steel plates, a method of construction particularly suitable to machines having to withstand the violent and repeated shocks of short-circuiting as part of their every-day routine. The windings are, of course, very strongly supported, and are insulated throughout with mica, the insulation being of a permanently flexible nature to allow it to accommodate itself to the unequal expansion of the copper and iron. There are two windings per phase, their ends being brought out to a convenient terminal board, where, by appropriate changes in the positions of the interconnecting links, the machine can be made to supply current at any of the four voltages for which it has been designed.

The rotor is of mild steel with end caps of high-tensile non-magnetic steel. Before delivery each rotor was subjected to a test at an overspeed of 25 per cent. for five minutes, and was balanced both statically and dynamically. Exciting current is furnished by an exciter on the end of each alternator shaft, the exciter fields being magnetised from an independent continuous-current machine. A separate motor-driven fan supplies air for ventilating the alternator. Since the duration of the short circuits is very brief, the ventilation is not of so much importance as usual, so that the volume of the ventilating ducts could be made much less than in an ordinary machine of the same size. The space thus saved provides room for an increased quantity of active iron and copper, and makes possible the particularly solid and compact arrangement of the winding. The rigidity which has been obtained will be evident from an inspection of the photograph of the end of the first alternator, taken during erection, reproduced in Fig. 130; the appearance of the same machine in its finished state is shown in Fig. 128. Many thousands of short-circuit tests have now been carried out with these machines without the least sign of mechanical or electrical trouble.

In consequence of the great inertia of the sets, they do not come to rest for a considerable time, something like half an hour, after their services are finished with, so that the lubrication of the bearings is of great importance. To avoid all possible risks in this matter, the bearings are supplied with oil by gravity from an overhead tank of sufficient capacity to keep them lubricated until the machine has stopped. This tank is continually replenished by a pump mechanically driven from the shaft of the unit. An electrically driven pump serves to fill the tank when the machine is at rest, and a hand pump is also available to raise oil to the overhead tank in cases of emergency. Another hand pump is used to force oil at a pressure of about 1000 lb. per square inch beneath the journals at starting. This raises the rotor and enables the motor to start easily. The arrangement obviates the use of a separate geared starting motor, which would otherwise have been needed to get so heavy a mass into motion.

FIG. 135—2000-KW "UNIPLANE" SET FOR PAPER MILL





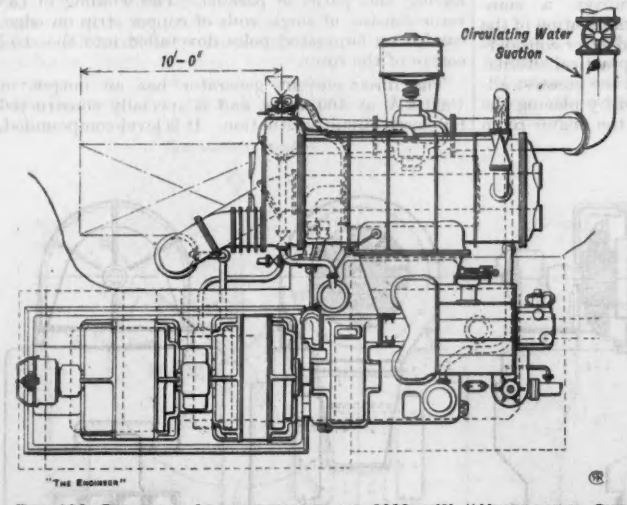


FIG. 134—GENERAL ARRANGEMENT OF 2000-KW "UNIPLANE" SET

ELECTRICAL DYNAMOMETER FOR TESTING AERO-ENGINES.

The earlier method of testing air-cooled aeroplane engines was to measure the power of the engine by a hydraulic dynamometer, cooling the cylinders meanwhile by an electrically driven fan. The whole of the engine power was thus uselessly absorbed, while some hundreds of horse-power had to be supplied from an external source to drive the fan. To avoid the obvious inefficiency of testing and running-in engines by this method, Mr. F. W. Highfield devised an electric dynamometer which not only facilitates power measurements, but enables the whole of the fan power required, which amounts to something like two-thirds of that developed by the engine, to be produced by the engine itself.

The essential part of the Highfield dynamometer is an A.C. machine of a very interesting type, specially designed by Messrs. Parsons for the objects in view. It can be used either as a two-phase generator, when its rated output is 430 kW at 1518 r.p.m., 3040 volts,

76 cycles and 0·9 power factor, or it can be employed as a motor giving 160 b.h.p. at 1000 r.p.m. when supplied with two-phase current at 2000 volts and 50 cycles. The stator of the machine is mounted on pedestals with roller bearings, enabling it to rotate through a limited angle. This provision allows the torque exercised by the engine, which is directly coupled to the rotor, to be accurately measured, so that, with a knowledge of the speed of the engine, the horse-power being developed at any time can be immediately ascertained. The current generated by the dynamometer is usefully employed in driving the fan. The dynamometer can also be used as a motor to start the engine or to run it round by power. When working as a motor the dynamometer can be run at any speed up to that of synchronism.

The stator, apart from the method of mounting already referred to, is of normal construction. Its casing is of welded steel. The windings are former wound, and held in open slots by means of fibre wedges. A photograph of the stator with end covers removed to show the windings is reproduced in Fig. 131. The rotor is of the wound barrel type, built up of core plate stampings keyed to the shaft, and provided with axial and radial ventilating ducts. The rotor conductors are of copper strip, insulated with mica and presspahn. They are secured in semi-open slots by means of dovetailed hardwood wedges, the end turns being secured by a wrapping of binding wire. The winding is a two-phase arrangement with the ends brought out to slip rings mounted on the end of the shaft, as shown in Fig. 132. When the dynamometer is running as a generator two slip rings are short circuited and the other two used for excitation purposes. Exciting current is provided by a separate motor-driven exciter. A direct-driven exciter could not be used because of the speed variation of the plant when in service. When it is desired to start the dynamometer up as a motor the four slip rings are used, the two phases being connected in series with a starting resistance. Alternatively, the rotor windings may be short circuited, and the machine run up as a squirrel-cage motor with an auto-transformer starter.

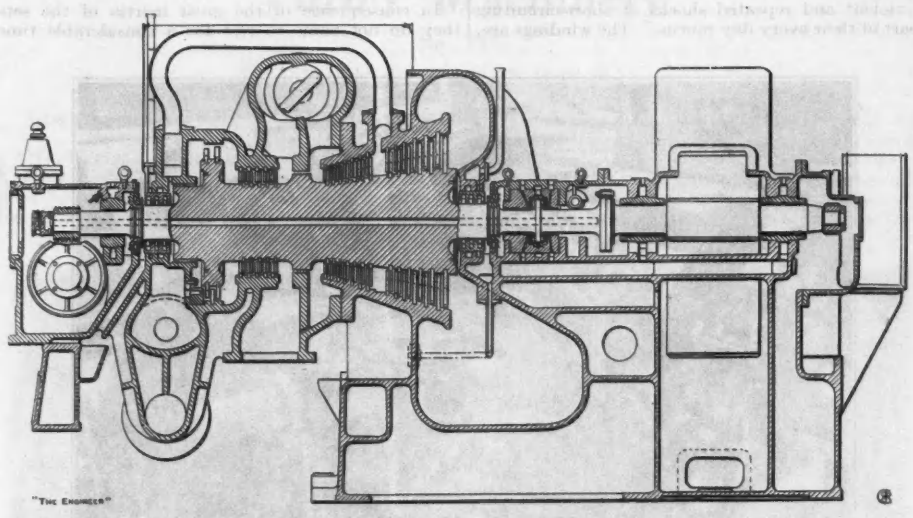


FIG. 136—SECTION THROUGH TURBINE FOR "UNIPLANE" SET

The machine was constructed by Messrs. Parsons for the Highfield Electrical Company, Ltd., in 1930, and is now in service at the Armstrong-Siddeley works at Coventry. Its appearance, before its despatch from Heaton, is shown in Fig. 129.

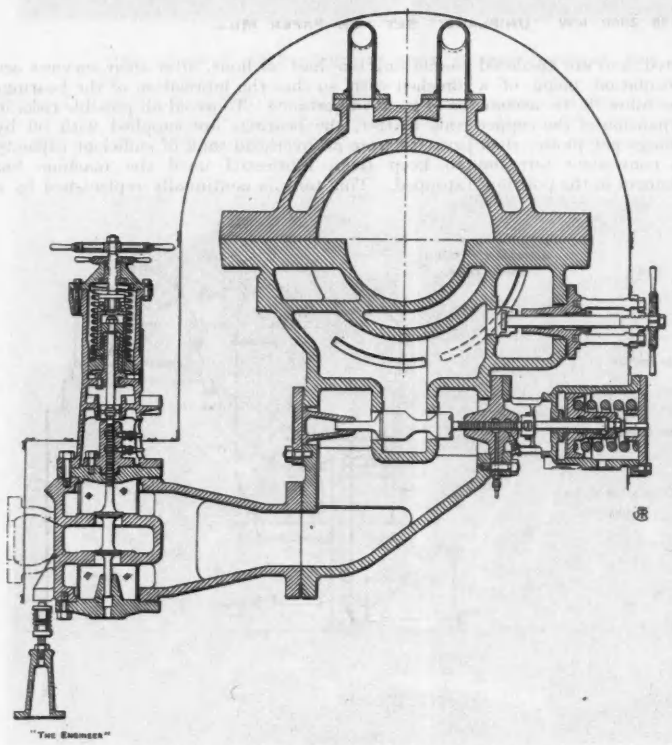


FIG. 137—CROSS-SECTION OF STEAM END

UNIPLANE PASS-OUT TURBINE WITH GEAR-DRIVEN ALTERNATOR AND D.C. GENERATOR.

The Uniplane type of turbine, requiring no basement room for the condenser, was first developed by Messrs. Parsons in the year 1896, as has already been recorded. A certain number of such machines were built about that time, but, being unsuitable for the larger units then coming into use for power station work, the type fell into disuse and its manufacture was discontinued for a number of years. In course of time, however, a demand arose for simple and compact turbo-generating units of relatively small output for industrial purposes, and in 1929 Messrs. Parsons again turned their attention to the Uniplane type. The progress made since its first introduction necessitated, however, a complete re-examination of the design, and after considering every practical alternative arrangement it was decided that the greatest all-round advantages would be obtained by placing the condenser alongside the turbine on the engine-room floor level. To put the matter to the test an experimental Uniplane machine of this kind was built at the Heaton Works in 1929. The set, which consisted of a geared turbine driving a 250-kW alternator, is illustrated in Fig. 133. Exhaustive shop trials, to determine the efficiency, reliability, and the general handiness of the type were carried on over a long period in order that the design might be put on the market with full confidence in its merits.

Following this experimental machine numerous geared turbo-alternators of the Uniplane type were constructed for service both at home and abroad, their outputs ranging from 500 to 1500 kW. Sizes naturally tended to increase, and in 1933 two quite large geared Uniplane machines were built, one of 2000 kW capacity for the Radcliffe Paper Mills Company, Ltd., and the other of 3000 kW capacity for the Australian Paper Manufacturers, Ltd., of Sydney, N.S.W. Of these, the Radcliffe unit, illustrated in Fig. 135, is perhaps the more interesting, in spite of its smaller capacity, as it consisted of a geared pass-out turbine running at 5500 r.p.m. and driving a 1000-kW D.C. generator in addition to a 1250-kW alternator and exciter, all three machines being in tandem and running at 750 r.p.m. The arrangement of the plant is shown in Fig. 134. The condenser, as will be seen, is placed at the side of the turbine, but in this case there is a basement, which allows room to be found in the foundation block for the ducts and apparatus in connection with the closed ventilating system for the two generators.

The turbine is supplied with steam at a gauge pressure of 175 lb. per square inch, superheated to 520 deg. Fah. at the stop valve. It will carry its full load of 2000 kW when any quantity of steam up to a maximum of 20,000 lb. per hour is being extracted at an absolute pressure of 30 lb. per square inch, or equally when no steam at all is being extracted and all passes to the condenser. From the longitudinal section through the turbine, shown in Fig. 136, it will be observed that the blading commences with a two-row velocity-compounded wheel, which is followed by eighteen pairs of reaction blade rows. Steam is passed out for process work from the belt after the first five pairs of rows of reaction blades. The automatic pass-out valve, which maintains the steam pressure constant in the pass-out main, is of the oil-operated rotary type, and is incorporated in the turbine cylinder. It works quite independently of the turbine governor, in the manner already described in connection with Fig. 121 *ante*.

A combined runaway and stop valve is contained in a separate chest bolted to the underside of the turbine casing. The governor throttle valve is mounted horizontally in the lower half of the turbine cylinder, and above it is the hand-operated overload valve. The arrangement and construction of all the three valves are shown in the cross-sectional drawing of the steam end of the turbine reproduced in Fig. 137. Oil at a pressure of 70 lb. per square inch operates the relays of the runaway and throttle valves. The oil for the throttle valve relay is controlled by a pressure-regulated port in the governor sleeve, as described in connection with the High Wycombe turbine, and illustrated in Fig. 116 *ante*.

Turning to the electrical end of the unit, the alternator has a capacity of 1250 kW at 0·7 power factor and 750 r.p.m. It produces three-phase current at 400 volts and 50 cycles. The machine is of the standard salient pole construction, with eight poles, and is provided with a casing of welded steel arranged for closed circuit ventilation. The stator core has open slots carrying a two-layer basket winding having four paths in parallel. The winding of the rotor consists of single coils of copper strip on edge, carried on laminated poles dovetailed into the steel centre of the rotor.

The direct-current generator has an output of 1000 kW at 460 volts, and is specially constructed for closed circuit ventilation. It is level-compounded,

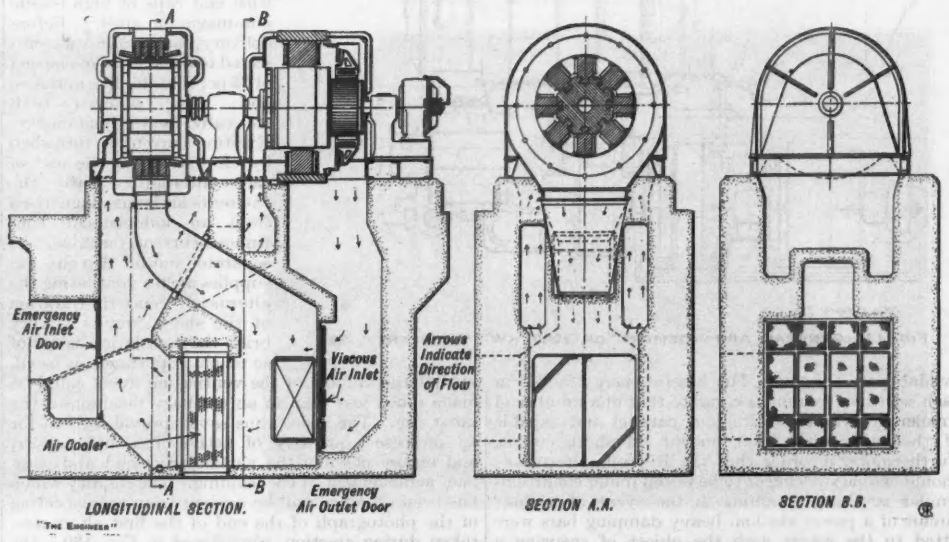


FIG. 138—VENTILATION OF GENERATORS OF "UNIPLANE" SET

with interpoles, and has a magnet yoke of welded steel. Like the alternator, it is fitted with Parsons patent non-metallic end shields, which, by being completely free from eddy currents and incapable of causing magnetic short circuiting, conduce materially to the high efficiency of the machines.

The ventilation of the alternator and continuous-current generator is of special interest, as it constitutes somewhat of a new departure in such matters. Both the machines are ventilated by a combined totally enclosed system, in which is incorporated a single air cooler, common to both circuits. The arrangement is illustrated in Fig. 138. As regards the alternator, the air, after passing through the cooler, is drawn axially through the end shields by the fan action of the rotor, and is returned to the cooler after passing through the radial ducts in the stator. This, of course, is simple, but the simultaneous ventilation of the continuous-current generator introduces new problems, particularly as regards the elimination of the carbon dust, produced by the brush gear, from the air circuit. The air current through the machine is maintained by a fan at the driven end of the armature shaft. This fan draws air through the cooler, forces it over the armature windings and field magnets, and discharges it over the commutator and brush gear. The carbon dust that may be picked up from the brushes is eliminated by an air filter of the viscous type, through which the air has to pass before returning to the cooler and mixing with the air from the alternator. The quantity of air circulating through each machine can be regulated by hand-operated damper doors fitted in the bed-plate. These doors also serve to isolate the air circuit of either machine, should it be desired to run this machine separately. Emergency doors are also fitted to enable the machines to be run on open air circuit should anything happen to the cooler or air filter. Since the commutator and brush gear of the continuous-current generator are, of course, entirely closed in, inspection windows are provided in the casing of these parts. These give access to the brushes when desired, and enable the commutation to be observed at all times. The application of so complete a system of closed ventilation to industrial generators, though unusual, has manifest advantages, for it prevents the accumulation of any dust or dirt in the windings, keeping the machines perfectly clean and cooling them with a plentiful supply of air at a steady temperature considerably lower than that of an ordinary engine-room. The benefits of the practice have, of course, been recognised for years in connection with the larger machines supplied to central power stations.

Automatic Synchronising Equipment.

No. I.

ADVANCES in the design of automatic control apparatus point to the possibility of a wider application of automatic synchronising equipment not merely in sub or switching stations, but in large power-houses. The synchronising of generators and frequency-load control between them are operations which, although hitherto generally carried out by hand, are amenable to automatic treatment. When generators are connected to the same network the problem arises of controlling the load between them whilst maintaining a constant bus-bar frequency. Complications have hitherto been an obstacle to the adoption of automatic synchronising and frequency-load sharing apparatus, but certain manufacturers now claim to have produced gear that is fairly simple and not unduly costly.

The paralleling of alternators demands great care. Although, in modern stations, highly skilled operators are employed, and the chances of a mistake may be very remote, experience has shown that the human element cannot invariably be relied on and that the cost of a mishap may be great. When it is remembered that one set of modern synchronising equipment can generally be employed for a number of machines; that it can be adapted for frequency control, and that the cost of the equipment is only a small fraction of that of the machine, the expense involved can scarcely determine the question of whether the machines shall be synchronised automatically or otherwise.

There are fundamental conditions that have to be observed in either automatic or manual synchronising. Two concern voltage, and the third relates to speed. To avoid setting up undue circulating currents, it is essential when paralleling alternators that the voltage of the incoming machine and that of the bus-bars should be as nearly as possible equal, and that there should be practically no phase difference between them; the speeds of the machines must be very nearly equal. Various schemes have been devised by different electrical manufacturers for paralleling alternators automatically. A simple and efficient scheme for synchronising alternators automatically has been developed by A. Reyrolle and Co., Ltd., of Hebburn-on-Tyne. The apparatus is entirely of the relay type, and Fig. 5 shows a typical panel carrying the relays and associated control equipment. After the voltage of the incoming machine has been adjusted to a value slightly above that of the bus-bars, the equipment can either complete the synchronising operation entirely automatically or partly automatically.

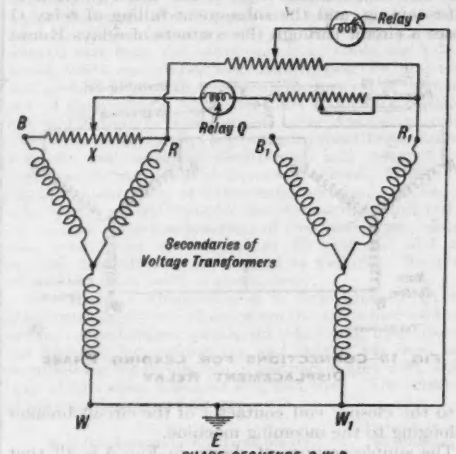


FIG. 1—RELAY CONNECTIONS

Leaving aside equipment such as low-voltage relays, governor control contactors, and manual to automatic change-over switches, we will consider the operation of the relays employed for the discrimination and control of speed and for ensuring that the voltages and phases of the two supplies are within predetermined limits before the final synchronising operation is completed. The diagram, Fig. 1, shows the connections for two relays, P and Q, between the phases of voltage transformers associated with the incoming machine and the bus-bar supply. It will be perceived that the white phase extremities W and W 1 are coupled together and earthed, and the vector relationship between the two supplies can be made clear by assuming that the bus-bar supply vector is stationary, so that the incoming machine vector may be regarded as rotating about it with the angular velocity which a synchroscope needle would possess. Although it is usual to consider the phase sequence to be R.W.B. and the "fast" direction of rotation to be anti-clockwise, Figs. 2 to 4 and 6 to 8 have been drawn for the sake of clearness with the "fast" direction clockwise so that the vectors are shown rotating in the same direction as the synchroscope needle, which approaches the "12 o'clock" position in the clockwise direction. As the diagram, Fig. 1, shows, the relay P is connected on one side to the mid-point of a resistance bridging the leading phases of the voltage transformer secondaries of the incoming machine and the bus-bar supply, the other side of the relay being connected to the common phase extremities W and W 1.

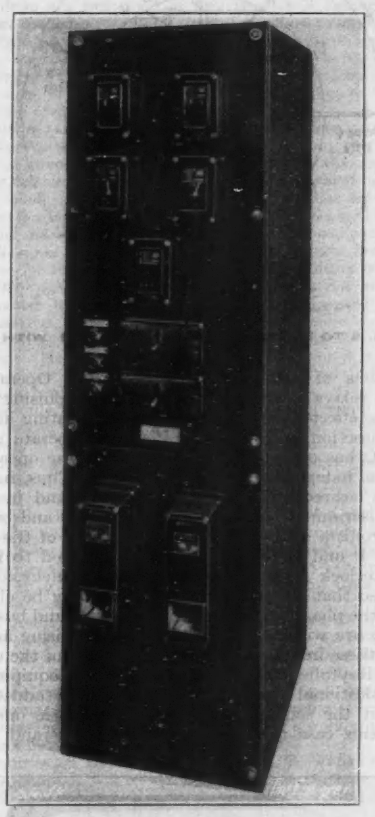
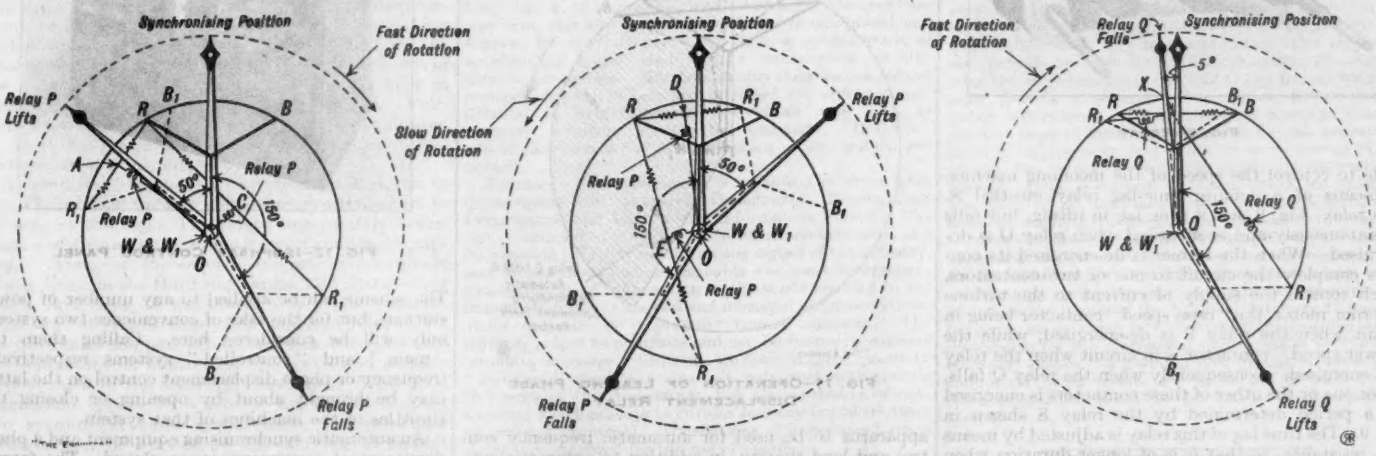


FIG. 5—SYNCHRONISING PANEL

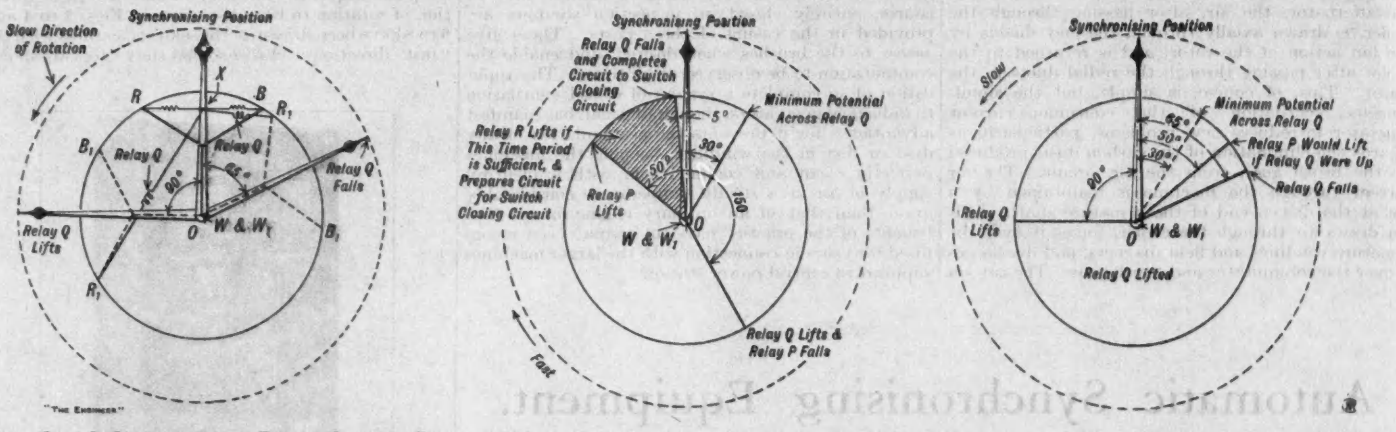
The diagrams, Figs. 2 and 3, show the angular position for the operation of relay P when the relative directions of the incoming machine vectors are "fast" and "slow," respectively, and it is clear that the lengths O A and O C in Fig. 2, and O D and O E in Fig. 3, are directly proportional to the potential difference across the relay P, which is at a maximum at the synchronising position. This relay is set to operate at approximately the angles indicated. Relay Q (Fig. 1) is connected on one side to the mid-point of a resistance between the leading and lagging phases of the bus-bar supply, and on the other side to the leading phase of the incoming machine, and



FIGS. 2 TO 4—OPERATION OF RELAY P WITH RELATIVE DIRECTION OF ROTATION "FAST" AND "SLOW" AND RELAY Q "FAST"

Figs. 4 and 6 show in a similar manner to that described the potential difference across relay Q, which has a minimum value when the incoming machine vector is 30 deg. in advance of the synchronising position, the distance X R_1 representing the potential difference across the relay being a minimum when R_1 is vertically above X.

The relay is set to operate as shown in the diagrams, but variation of the settings of either relay is obtained by adjusting the resistances shown in Fig. 1. The diagrams, Figs. 7 and 8, show the combination of operation of relays P and Q in both



FIGS. 6 TO 8—OPERATION OF RELAY Q WITH RELATIVE DIRECTION OF ROTATION "SLOW" AND "FAST" AND RELAYS P AND Q COMBINED "SLOW"

directions of rotation of the vectors. Operation of the relays is arranged so that synchronising can only be effected when the vectors are rotating in the fast direction. While relay P cannot operate until relay Q has operated, it can remain in the operated position independently of the relay Q. Thus, in the "slow" direction relay P cannot lift, and in this way discrimination between speeds above and below synchronism is obtained. The operation of the two relays P and Q can obviously be adjusted to form an interlock with manually operated synchronising gear, so that the circuit breaker can only be closed when the phases of the incoming machine and bus-bar supply are within a permissible synchronising angle. Since these interlocking relays form part of the complete Reyrolle automatic synchronising equipment, the additional apparatus can easily be added to convert the scheme into a fully automatic one.

In this case the operation of relays P and Q is

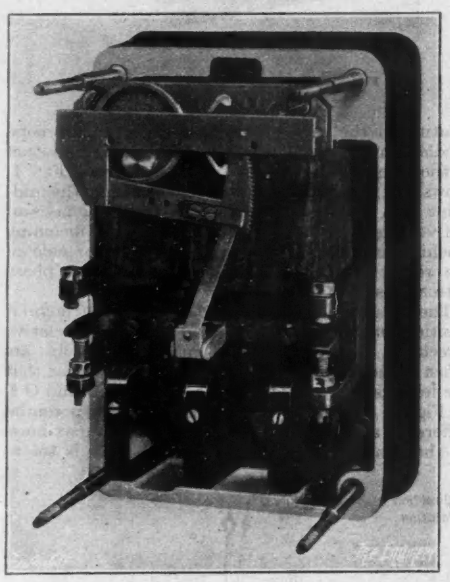


FIG. 9—RELAY

made to control the speed of the incoming machine by means of a definite time-lag relay, entitled S. This relay, Fig. 9, has a time lag in lifting, but falls instantaneously and is energised when relay Q is de-energised. When the former is de-energised its contacts complete the circuit to one of two contactors, which control the supply of current to the turbine governor motor, the "raise speed" contactor being in circuit when the relay P is de-energised, while the "lower speed" contactor is in circuit when the relay P is energised. Consequently when the relay Q falls, either one or the other of these contactors is energised for a period determined by the relay S shown in Fig. 9. The time lag of this relay is adjusted by means of a resistance, so that it is of longer duration when the incoming machine is "slow" than it is when it is "fast," and this causes the incoming machine speed to be raised quickly just above synchronism, and then to be slowed down to synchronous speed by fine control.

One impulse for every revolution of the rotating vectors is given to the governor motor. The duration of these correcting impulses is always the same, but the rate at which they are given decreases as the incoming generator approaches synchronism, and a very rapid but steady control is thus obtained. Before the incoming machine circuit breaker can be closed it is necessary to ensure that the synchroscope needle is rotating slowly in the "fast" or clockwise direction. An additional relay, referred to as relay R, in Fig. 7, is therefore provided, and lifts with a definite time-delayed action, and releases instantaneously. It is energised to enable it to begin lifting when relay P lifts and continues lifting until relay Q falls, when it falls itself and awaits the next lifting operation of the relay to begin the process over again, unless the interval between the lifting of P and the falling of Q is long enough to allow relay R to complete its own lifting. In the latter case the last-mentioned relay does not fall, because after it has lifted fully, it is self-retaining, and the subsequent falling of relay Q closes a circuit through the contacts of relays R and

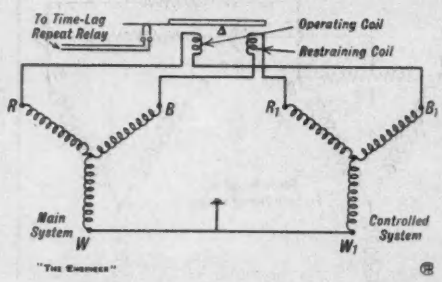


FIG. 10—CONNECTIONS FOR LEADING PHASE DISPLACEMENT RELAY

Q to the closing coil contactor of the circuit breaker belonging to the incoming machine.

The simple equipment shown in Fig. 5 is all that is required to synchronise an incoming machine with a bus-bar supply after the two have been prepared for synchronising. Relays P, Q, R, and S are to be seen at the top of the panel, the equipment below being the auxiliary equipment. Without any addition the equipment can be used for automatic frequency control and since this is closely connected with load sharing, the addition of load-sharing relays enables the

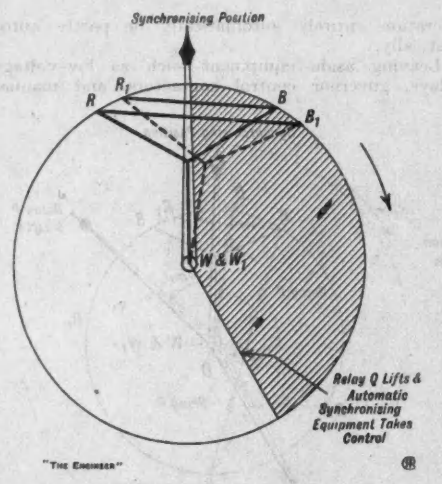


FIG. 11—OPERATION OF LEADING PHASE DISPLACEMENT RELAY

apparatus to be used for automatic frequency control and load sharing, in addition to automatic synchronising. To keep the station frequency constant it is matched and adjusted to a standard constant frequency (obtained from a small time-controlled motor generator) by the relays P, Q, and S. Instead of matching the incoming machine frequency with that of the bus-bar supply, as when synchronising, the relays match the frequency of the station bus-bars with the constant frequency. Impulses originated in the same way as when synchronising are caused to act on the governor motors of running machines through contacts on load-sharing relays, and adjust the output of any particular machine to a predetermined value, while its frequency is maintained constant.

The Isophase control system developed by A. Reyrolle and Co., Ltd., embodies the automatic synchronising scheme described and incorporates other novel automatic features. Although the interlinking of electrical networks provides economic advantages by reducing the amount of standby plant and by allowing the most efficient stations to run to the best advantage, it introduces the danger on the occurrence of faults of interrupting the supplies to large areas. Captain J. M. Donaldson, chief engineer of the North Metropolitan Electric Supply Company, suggested, however, that if the smaller networks could be maintained in close synchronism, so that they might be connected together when required, the advantages of interlinking would be retained without introducing any of the disadvantages. The Isophase control system was therefore designed for that purpose, and the first equipment has been built for the undertaking with which Captain Donaldson is associated.

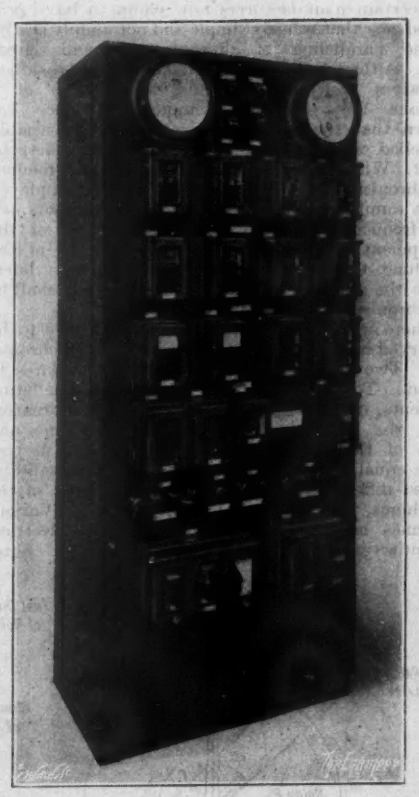


FIG. 12—ISOPHASE CONTROL PANEL

The scheme can be applied to any number of power stations, but for the sake of convenience two systems only will be considered here. Calling them the "main" and "controlled" systems respectively, frequency or phase displacement control on the latter may be brought about by opening or closing the throttles of the machines of that system.

An automatic synchronising equipment and a phase displacement equipment are employed. The former is similar to that described, and its function is to bring the main and controlled systems into synchronism, when the latter is started up or after it has fallen out of step as the result of some severe external disturbance. When synchronism is reached, however, instead of a circuit breaker connecting the two systems together, a change-over relay transfers the

control to the phase displacement equipment which forms the main part of the Isophase scheme and serves to keep the two systems in close synchronism, unless, owing to some disturbance, they fall out of step. In the event of this happening the automatic synchronising equipment takes charge, brings the two systems into step again, and then transfers them back to the control of the phase displacement equipment. When the two systems are brought into "close synchronism," as described, they may be connected together at any instant without giving rise to undue disturbance.

The points at which the systems are paralleled are preferably chosen to give a large amount of reactance between the generating sources, as it is then possible to connect the two systems together, even if the phase difference between them is relatively large. It is essential that the fundamental difference between the automatic synchronising and phase displacement equipments should be properly understood. All synchronising equipments depend for their operation upon a "slip frequency" between the main and controlled power systems. The controlled system must run at a frequency slightly above or below that of the main system before the synchronising equipment can operate, and synchronising is effected with the positions of the vectors of the systems coincide and the "slip frequency" is so small that the systems will pull into step. The operation of the "Isophase" phase displacement equipment, on the other hand, is based upon a determination of the angular displacement between the systems operating at the same frequency. While the automatic synchronising equipment functions when a "slip frequency" exists and does not do so when there is an angular displacement only and no slip frequency, the phase displacement equipment functions with angular displacement and not when there is slip frequency alone.

The main components of the phase displacement equipment are the phase displacement relays, which determine whether the angular displacement between the two systems exceeds a given amount, and whether the controlled system is in advance of or behind the main system. Connections for the leading phase displacement relay or the relay that operates when the controlled system is in advance of the main system are given in Fig. 10, while Fig. 11 is the corresponding vector diagram. The balanced beam relay has an operating coil which tends to close the contacts and a restraining coil which tends to keep them apart. The coils are connected between a phase of the main system and the phase in the case of the operating coil that lags behind, and, in the case of the restraining coil, is in advance of the corresponding phase of the controlled system. The operating voltage $R B_1$ and the restraining voltage $B R_1$ vary with the angular displacement between the two systems, and Fig. 11 shows that when the controlled system is in advance of the main system the operating voltage $R B_1$ exceeds the restraining voltage $B R_1$. The relay then closes its contacts and by means of a time lag repeat relay sends out impulses to the governor control motor, which closes the throttle of the machine of the controlled system, thus reducing the angular displacement between the two systems.

A lagging displacement relay operating upon similar lines comes into play when the controlled system lags behind the main system. Whenever a phase displacement occurs that does not exceed the angle represented by the shaded area in Fig. 11, the two phase displacement relays ensure that the voltage vectors of the controlled system are brought back to the same angular position as those of the main system. But if the angle represented by the shaded area is exceeded the automatic synchronising relays P and Q described earlier take control and bring the two systems back into synchronism, when the control is again transferred to the displacement relays. To this brief description we only need add that besides the relays mentioned another relay allows graded impulses, depending upon the amount of displacement, to be sent out to the controlled system, whilst under-voltage and alarm relays disconnect the "Isophase" equipment and give alarm in the event of the main and controlled systems not being kept in synchronism during a predetermined period. Voltmeters are also provided so connected and calibrated to give the phase displacement between the two systems at any instant.

A complete "Isophase" control panel is shown in Fig. 12, in which the two voltmeters mentioned are to be seen at the top. The relays immediately below them constitute the automatic synchronising equipment. Those in the second row are under-voltage relays, those in the third row timing and change-over relays, and those in the fourth row phase displacement, out of synchronism, and indicator relays. At the bottom of the panel there is a lock-out relay and the contactors for controlling the speed and angular displacement of the controlled machines. While this description applies to a scheme capable of keeping two systems in close synchronism, the principles involved can be applied to the solution of similar problems.

(To be continued.)

ACCORDING to official statistics, the total turnover of the Leipzig Fair amounted to some £25,000,000, of which £7,500,000 were exports.

Research into Cast and Malleable Cast Iron.

(Statement Issued by the British Cast Iron Research Association.)

SINCE 1924 the British Cast Iron Research Association has nearly trebled the subscription income which it receives from the industry, mainly, of course, by extension of membership. The balance of its income is received in the form of a grant from H.M. Government. During the early years this grant was at the rate of £1 per £1 on industrial subscription income, reaching a maximum figure of nearly £5000 in 1931. During the following three years the grant was reduced to £3000, but by 1934 the resulting drop in income had been more than made good from industrial sources, the total income for that year being the highest on record.

Government Offer.—For the current financial year H.M. Government, through the Department of Scientific and Industrial Research has made a generous offer to increase the grant by £2000, provided that additional subscription income to the extent of £1000 is forthcoming from the industry. In order that full benefit may be obtained from this proposal, the Council of the Association seeks the co-operation and support of all foundries eligible for membership. If the necessary condition can be met, the total income for the current year will reach £13,000. The Government offer goes further, and the grant will be increased beyond the figure mentioned, at the rate of £1 for £1, up to a limit of £3500, on all subscriptions received over and above the required initial sum of £1000. The Council aims to take the fullest advantage of this offer within a period of five years, so that by 1939 the Association's income will reach £20,000, consisting of £10,500 from industry, £8500 from grant, and £1000 from miscellaneous non-grant-earning income. It will be noted that while the grant fell from the original £1 per £1 to 10s. per £1, if the fullest advantage is taken of the new proposals it will reach about 16s. per £1.

Constitution.—We recapitulate some features of the Association's constitution and work. It is an entirely self-governing body of national status. The Council is elected by members at the annual meeting, and operates principally through three main committees, the Research, Publications, and Education Committees. There are eight Research Sub-Committees supervising definite sections of the field covered—pig iron, grey cast iron, alloyed cast iron, malleable cast iron, sands and refractories, white and chilled iron, melting practice, and tests and specifications. Over 200 representatives of members act on these various committees and about fifty meetings are held in the course of the year. The Association maintains close contact with various Government Departments, scientific and technical institutions, and research and trade associations, both at home and abroad. It does not engage in any form of commercial activity, and has no interest to serve but that of its members and of the industry as a whole. The headquarters of the Association, offices, and laboratories, are located at Birmingham, and the Scottish laboratory is maintained at Falkirk. The total staff of the Association is about thirty.

Membership.—Membership is in three grades. By far the largest proportion of industrial income is derived from ordinary members, comprising manufacturing firms operating furnaces for making pig and refined pig iron, and foundries for the production of castings in grey iron, white iron, chilled iron, malleable iron and steel. The schedule of subscriptions is as follows:—

	Per annum.
Blast-furnaces and refined iron plants ..	25 guineas
Foundries (grey iron, white iron, chilled iron, malleable iron or steel):	
Employing under 50 on the weekly pay roll	5 ,,
Employing over 50 and under 250	25 ,,
Employing over 250 and under 500 ..	50 ,,
Employing over 500 and under 750 ..	75 ,,
Employing over 750	100 ,,

The qualifying employment figure includes all on the foundry weekly pay roll, both skilled and unskilled labour, other than clerks, engineering machinists, and patternmakers. These subscriptions, by arrangement with the Commissioners of Inland Revenue, are treated as business expenses for income tax purposes. With one or two isolated exceptions, the subscription is inclusive, and no charge is made to members for services rendered.

The Council welcomes the co-operation of users of cast iron, that is, of engineering and other firms who purchase cast iron, and also makers of all forms of equipment and supplies for the industry. For these a special grade of membership is provided with a subscription of five guineas per annum. Members in this class do not receive research reports, which are intended for and are confidential to manufacturers. Individuals may also, as associate members, receive the quarterly "Bulletin" and library service at a subscription of one guinea per annum.

Activities.—The Association is organised in three main departments—the Research Department, Development Department, and Library and Information Bureau. The last mentioned is intended to furnish members with any information they may require on any aspect of the industry, and its resources include probably the most comprehensive collection of information in the world relating to the foundry industry, classified and arranged on modern lines, under the care of a properly trained assistant. The material is lent to members and can be borrowed without formality or charge. Additions are notified in the quarterly "Bulletin," which contains not only technical articles and news of the Association, but also abstracts of outstanding developments in current foundry literature from all parts of the world. Translations of important foreign papers are prepared for the use of members.

The Development Department is charged with the task of assisting members to apply to practice discoveries made in the laboratories, and of dealing with practical inquiries from members on any foundry matter in which they are interested. The latter are dealt with at the present time at the rate of about four per working day, and cover a very wide field, including raw materials, mixtures, melting practice, sands, refractories, design of castings, after treatment, defects and failures, &c. The responsible members of the staff work on secrecy agreements, and information received from members and reports furnished are treated as strictly confidential, and are not disclosed, even to the Council. Tests involved in such inquiries, in the chemical, microscopic, and mechanical testing laboratories are carried out without charge. Arrangements are made for visits to members' works in connection with such inquiries, when necessary.

The research programme is formulated by the Research Committee and covers a wide range of problems of immediate concern to the industry, such as the metallurgy of cast iron, moulding sands, refractories, cupola melting. The extension scheme is enabling the Council to provide for investigations on alloyed cast irons, on shrinkage and contraction, and on bonding clays for natural and synthetic sands. Research reports are circulated or made available to members as and when complete. The Association is empowered, under its articles, to undertake special investigations for members at cost. Visits from members are welcomed at any time, and arrangements can be made for representatives of members to study in the laboratories for chemical analysis, microscopic examination, mechanical testing, sands and refractories investigation, and metallurgical research for short or long periods. Meetings of members are held periodically to discuss matters of special interest.

Invitation to Non-members.—While the existing members of the Association probably comprise a majority of the capital involved and labour employed in the industry, there remains a large number of foundries which have not yet joined, and the Council feels that a wider knowledge of the work of the Association will justify these foundries in the necessary expenditure. For the comparatively small sums shown in the above table, these firms can ensure for themselves benefits of an expenditure of about £12,000 per annum. Since British industries are now protected by tariffs, H.M. Government regards it as imperative that they do everything possible to equip themselves technically to meet the demands of consumers. Membership of a research association is regarded as evidence of such a desire on the part of individual manufacturers.

The only limitation with respect to membership is that the foundry concerned must be British—that is, over half the capital and/or directorate must be British. Foundries excluded by this provision may be elected to full membership with the consent of the Board of Trade, and provided British labour is employed, this consent is not unduly withheld. British foundries overseas are also eligible for membership, and the Association has members in Australia, New Zealand, India, and South Africa. The rapid development of the air mail has overcome the principal handicap to members overseas, that of the time lag in communication.

In practice, no difficulty has been found in ensuring the co-operation of members on a technical and scientific basis. It is estimated that in the aggregate members are obtaining each year economies which offset the subscription several times over, and the adoption throughout the industry of the results of the Association's work will effect savings of the order of a quarter of a million sterling per annum.

Inquiries to the Association at 21, St. Paul's-square, Birmingham, 3, will be welcomed, and the Director will be prepared to visit personally foundries interested in and desirous of considering membership.

AMERICAN AVIATION POLICY.

RECOMMENDATIONS for a broad aviation policy on the part of the American Government are embodied in the recent report of the Federal Aviation Commission. On the basis of studies of home and foreign practice, the report states that nowhere else are passengers, mail, and goods carried with such regularity and speed, by day and night, with such comfort and convenience, and on anything like so broad a network as in the services of the major American air lines. On the other hand, a considerable part of the air transport system is operated at a loss, which is a situation that cannot be continued indefinitely. About 56 per cent. of the air transport service is rendered by machines cruising at a speed of 160 miles an hour or more. Air mail should be put on a flat pound-mileage basis, and operated under a Commission and regulated through certificates of convenience and necessity, thus eliminating unnecessary duplication of service. All air lines maintaining regular service should be considered as common carriers for the transport of mail, in the same way as the railways. But they must also provide suitable facilities for handling the mail, to meet the requirements of the Post Office Department, and must provide a general transportation service for the public convenience. The Commission considers that the greatest hope of building up a great aircraft industry to provide employment, and available as a reserve in case of war, lies in the development of private ownership of aircraft, which is already large and should be extended. The need of an adequate airport system is recognised, and the lighting of airports is considered comparable to the provision of harbour lights and buoys. On this basis, the Government should assume the responsibility for the installation cost of lighting, and also a part of the maintenance cost. Research and educational work is to be left in the hands of the National Advisory Committee for Aeronautics which is credited with the features largely responsible for the spectacular performances of American transport planes. A training airship and an airship for commercial trans-oceanic service should be built by the Government, the latter to be leased to an operating company.

AT the spontaneous invitation of the Chinese Government, Brigadier-General F. D. Hammond, assisted by Messrs. L. J. L. Lean and F. J. M. Taylor, of the Great Western Railway, have undertaken to examine and advise upon the reorganisation of the Chinese railway system. The party sailed on April 4th.

The Twenty-four-Foot Wind Tunnel at Farnborough.

No. II.

(*Continued from page 353, April 5th.*)

General Arrangement of the Building.

FROM the illustrations accompanying the previous article it will be observed that there is a considerable lack of uniformity in the general arrangement of existing wind tunnels. For example, at the Chalais-Meudon station the air, drawn in at one end of the building, passes through it in a straight path and is discharged into the atmosphere at the other end. At the other end of the range we have the compressed air tunnel at Teddington in which the air, after crossing the working space, flows back through an annular return passage to the entrance and is re-circulated. A similar general arrangement characterises the N.A.C.A. variable density tunnel. In the case of these two tunnels re-circulation of the air is dictated by considerations of economy, because of the expense involved in compressing a large volume of air to a pressure of 20 or 25 atmospheres. The 9ft. tunnel at Teddington, although it employs air at atmospheric pressure, also makes use of the re-circulation principle, the air after leaving the tunnel exit finding its way to the entrance again through two return passages, one above and one below the tunnel. The American 20ft. and 60ft. tunnels are similar except that the two return passages are arranged at the sides of the tunnel. In the case of atmospheric tunnels re-circulation of the air is dictated, at least in part, by a desire to conserve the kinetic energy in the air leaving the tunnel. Other considerations also play a part in favour of the re-circulation of the air. For example, with re-circulation the quality of the air is less liable to erratic variation and some economy is in general possible in the length of the building required to house the tunnel.

A disadvantage of the atmospheric tunnel with the air re-circulated through passages at the side lies in the fact that access to the working chamber necessitates the provision of doors in the walls of at least one of the passages. These doors restrict the freedom with which the machine or model may be taken into the working chamber and must be kept closed during a test. If the return passages are arranged above and below the tunnel sideways freedom of access to the working chamber is secured but the headroom within that chamber is restricted.

At Farnborough the new 24ft. wind tunnel is arranged on a plan different from that of any of the tunnels previously illustrated. The air is re-circulated through a single return passage lying behind the tunnel. With this arrangement access to the working chamber from the front is quite unrestricted, and the head room above the chamber may be of unlimited extent. This arrangement has a very material influence on the economy of working of the tunnel. In an equipment of the size and capital cost of that under consideration it is very desirable that it should be possible to operate it with the least amount of idle time between experiments. In the Farnborough tunnel the working space—it can hardly be called a chamber—is open at the front side to a large bay of the building, and, as shown in one of the half-tone engravings on page 386, is served by two cranes by means of which a machine may be swung into it from one end of the bay or out of it into the other end. Hence while one machine is under test another may be in the bay being mounted and otherwise prepared for testing. Alternatively on a floor above the tunnel a model or component may be mounted on a carriage and prepared for testing ready to be lowered down into the working space as soon as it becomes vacant. Two carriages are in actual fact provided so that if one model test has to succeed another the second model may be undergoing mounting and preparation while the first is being tested. The single return-passage arrangement, it may be noted, is also adopted in the German wind tunnel at Göttingen, in the tunnel of the California Institute of Technology, Pasadena, and at a number of other establishments.

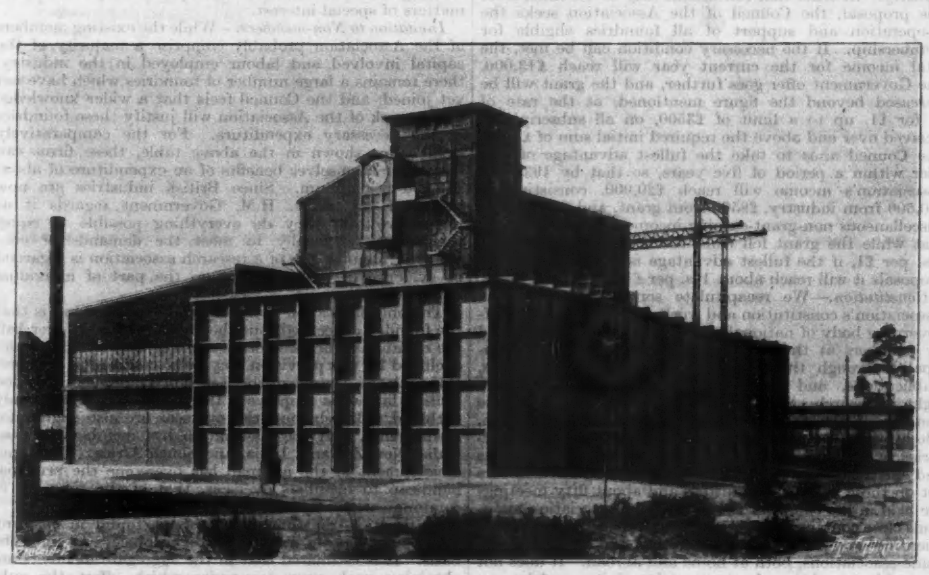


Fig. 9—General View of Wind Tunnel Building

Construction of the Building and Tunnel.

Sectional plans and elevations of the building and tunnel are reproduced herewith. The building in general is a steel framework encased in concrete with a superstructure finished on the outside with Ruberoid steel roof deck. A shed with large folding doors at each end extends along one side of the main building and constitutes the bay in which the full-size machines are prepared for testing. Within the superstructure there are sundry offices, workshops, machinery rooms, and other accommodation, but its main purpose is to house the model carriages and the equipment for raising and lowering them from, or into, the air stream passing across the working space below.

The actual tunnel is a reinforced concrete structure occupying the whole of the interior of the main building. Looking at the working space from the aeroplane bay we have on the left a bell-mouthed orifice into which the air is drawn by a fan situated a short distance beyond the smaller end of the bell-mouth. The larger diameter of this bell-mouth or collector is 40ft. and the smaller 30ft. As the delivery orifice on the other side of the working space is 24ft. in diameter it follows that considerable allowance is made for the expansion of the air jet while passing across the working space. A portion of the air jet impinges against the flared surface of the bell-mouth and passing through a large number of holes therein is delivered to the outside atmosphere, the delivery if required being assisted by extractor fans situated in a chamber in the superstructure. The air lost from the jet in this manner is made good by fresh air drawn in through louvres at the opposite end of the superstructure and delivered by injector action through a series of holes surrounding the 24ft. delivery orifice on the right of the working space. This arrangement for the extraction of a portion of the air in circulation and the admission of a make-up supply is designed to limit to a safe value the contamination of the air jet with exhaust gases when a machine is being tested with its engine running.

Just beyond the last ring of holes in the bell-mouth a grid of cross-wires attached at their ends to springs extends over the full area of the tunnel. The object of this grid is to protect the fan behind it from any object or body which might become detached from the machine or part under test and be carried into the collector by the air current.

The 30ft. diameter six-bladed fan is made of mahogany and rotates with small clearance within a short length of the tunnel lined with pine finished to circularity with a high degree of accuracy. At one point the clearance between the blade tips and the lining is reduced to a very small amount by the insertion in the lining of an upstanding contact which if it is struck cuts out the fan motor. This precautionary measure protects the fan and motor from damage in the event of the blades distorting in a manner to increase their length or of dirt or other obstruction becoming lodged between their tips and the lining.

The boss of the fan is shrouded by a hemispherical metal cap and behind the fan the driving shaft is

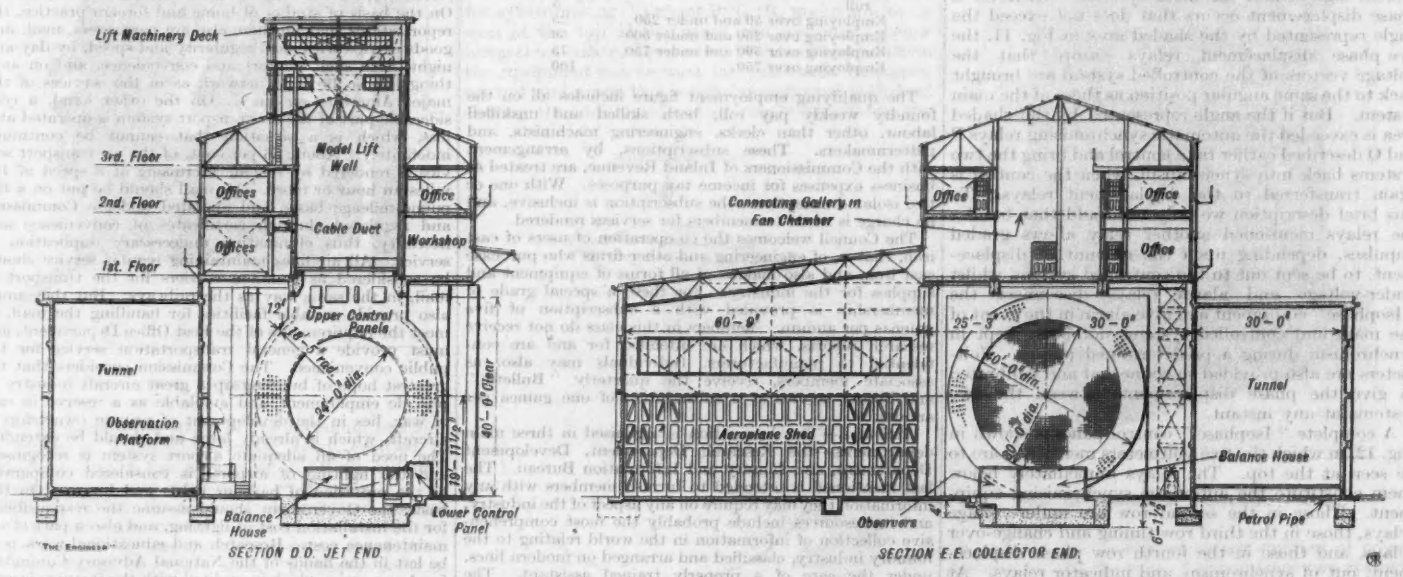
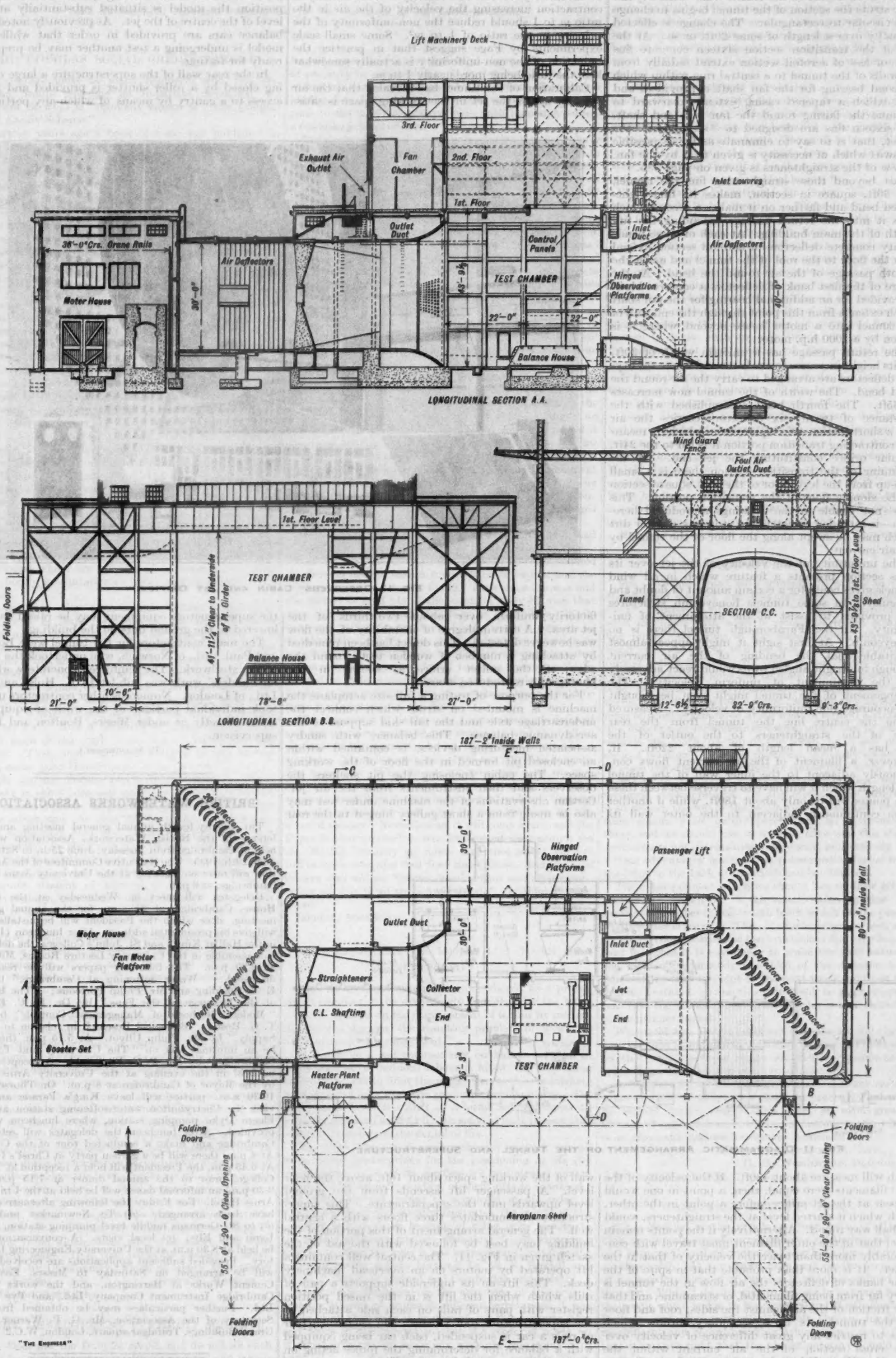


Fig. 10—Cross Sections of the Tunnel Building

THE R.A.E. 24-FOOT WIND TUNNEL, SOUTH FARNBOROUGH



encased in a sheet metal cylinder of the same diameter as the cap. The outer bearing of the fan shaft is supported on two inclined streamlined struts springing from the lower part of the tunnel wall. Just beyond these struts the section of the tunnel begins to change from circular to rectangular. The change is effected gradually over a length of some 20ft. or so. At the end of the transition section sixteen concrete fins more or less of aerofoil section extend radially from the walls of the tunnel to a central ring within which a second bearing for the fan shaft is provided, and from which a tapered casing extends rearward to continue the fairing round the fan boss and shaft. The sixteen fins are designed to "straighten" the air jet, that is to say to eliminate as far as possible the swirl which of necessity is given to it by the fan. A view of the straighteners is given on page 386.

Just beyond these straightening fins the tunnel, now 30ft. square in section, makes its first right-angled bend and farther on it makes a second which leads it into the return passage extending the full length of the main building. At each of these bends twenty concrete deflectors of aerofoil section extend from the floor to the roof of the tunnel and assist the smooth passage of the air round the bend. At the centre of the first bank of deflectors a concrete block is provided for an additional bearing for the fan shaft which extends from this point through the end wall of the tunnel into a motor house beyond, where it is driven by a 2000 h.p. motor.

The return passage has a uniform width of 30ft. but its height increases towards the end where twenty-two deflectors are arranged to carry the air round the third bend. The width of the tunnel now increases to 35ft. The fourth bend accomplished with the assistance of twenty-six deflectors carries the air into a short section 40ft. square from which by means of a contracting transition portion it is led to the 24ft. circular orifice constituting the jet end. At the beginning of the transition portion there is a small step-up from the level floor of the 40ft. square section to the sloping floor of the transition portion. This step—not visible in the drawings reproduced herewith—is intended to catch and stop any dust or dirt which may be swept along the floor of the tunnel by the air current.

The uniformity of the velocity of the jet over its cross section presents a feature which in all wind tunnels gives cause for a certain amount of doubt and difficulty. In some tunnels honeycomb structures are provided to assist in the attainment of uniformity. In the Farnborough tunnel there is no honeycomb. At first sight it might appear almost inevitable that the bending of the air current through four right-angled turns would react adversely on the attainment of uniform velocity. The arrangement of the tunnel might even be thought to encourage non-uniformity of velocity. Measured along the centre line the tunnel from the rear face of the straighteners to the outlet of the jet has a mean length of about 220ft. If, however, a filament of the air current flows continuously adjacent to the inner wall of the tunnel the length which it will have to traverse between these two points will be only about 180ft. while if another flows continuously adjacent to the outer wall its path will measure about 430ft. If the velocity of the two filaments were equal, then, a point in one would appear at the jet orifice before a point in the other, with which it started level at the straighteners, would be half way round. Alternatively if the points remain level that in the outer filament must travel with considerably more than twice the velocity of that in the inner. It is more than probable that in spite of the four banks of deflectors the air flow in the tunnel is very far from being filamental, or streamline, and that the friction of the air against the sides, roof and floor of the tunnel sets up a secondary airflow which acts to restrict any great difference of velocity over the cross section of the air current within the tunnel. Nevertheless it cannot be doubted that the air arrives at the transition portion preceding the jet orifice with a considerable lack of uniformity in its velocity.

The explanation of the paradox lies in the transition section and its action on the air. The effect of the contraction is to induce a very considerable degree of uniformity in the air velocity. Theoretically a contraction increasing the velocity of the air in the ratio m to 1 should reduce the non-uniformity of the velocity in the ratio of 1 to m^2. Some small-scale experiments by Fage suggest that in practice the reduction of the non-uniformity is actually somewhat less, the ratio being more nearly 1 to m.

Calibration of the tunnel has revealed that the air velocity across the jet in the working space is satisfactorily uniform over about two-thirds of the jet area. A certain degree of instability of the flow was however detected. This defect has been remedied by attaching a number of wooden teeth round the edge of the outlet orifice as shown in the photograph reproduced above.

For the purpose of testing a full-size aeroplane the machine is mounted on struts which connect the undercarriage axle and the tail skid support to the aerodynamic balance. This balance, with sundry associated measuring devices, is contained within an enclosed pit formed in the floor of the working space. The cabin enclosing the pit shelters the observers and their instruments from the air jet. Certain observations of the machine under test may also be made from a short gallery hinged to the rear wall of the working space about 16ft. above the floor level. A passenger lift ascends from the ground level upwards into the superstructure. This superstructure accommodates three floors with a central well. The general arrangement of this portion of the building may best be followed with the aid of the sketch given in Fig. 11. The central well contains a lift operated by motors on an overhead machinery deck. This lift on its underside supports a pair of rails which when the lift is in the raised position register with pairs of rails on each side attached to the superstructure roof trusses. On each such pair of rails a car is suspended, each car being equipped with a balance for determining the forces acting on the model suspended from it. The preparation of the model and balance is carried out while the car is withdrawn into its bay in which position the various parts requiring attention may be conveniently reached from one or other of the floors of the superstructure. When the model is ready it is run forward with its carriage on to the rails of the central lift and is thereafter lowered into the working space. In the lowered position the model is situated substantially at the level of the centre of the jet. As previously noted two balance cars are provided in order that while one model is undergoing a test another may be prepared ready for testing.

In the rear wall of the superstructure a large opening closed by a roller shutter is provided and gives access to a gantry by means of which any portion of the superstructure equipment may be raised from or lowered to the ground outside the building.

The main contractors for the tunnel were Boulton and Paul, Ltd., of Norwich, who undertook the whole of the steelwork. The reinforced concrete work and all builders' work was sub-let to K. Holst and Co., Ltd., of London. Numerous other contractors undertook individual portions of the work or equipment either directly or under Messrs. Boulton and Paul's supervision.

(To be continued.)

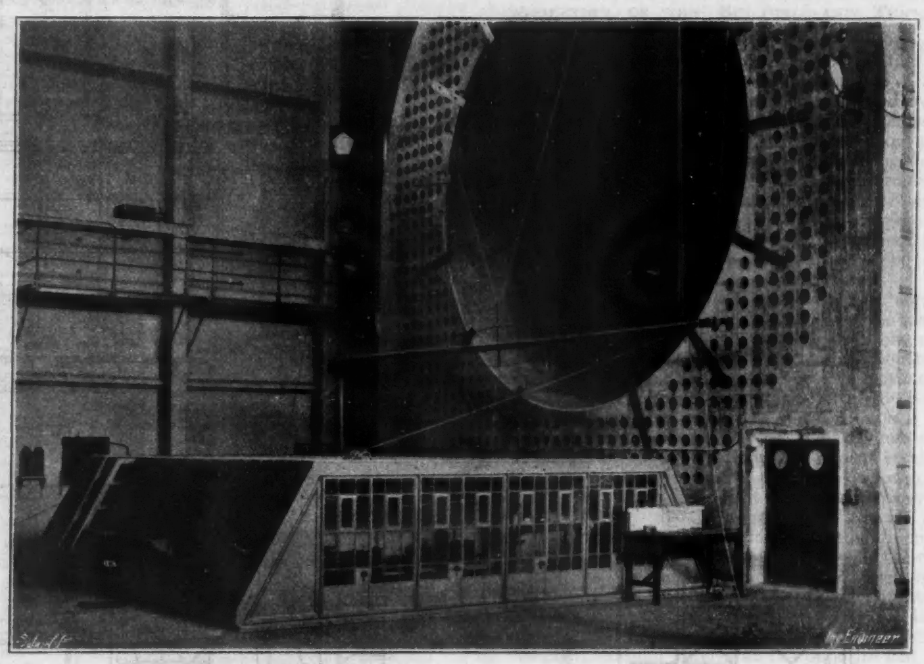


FIG. 12—OBSERVERS' CABIN AND JET ORIFICE

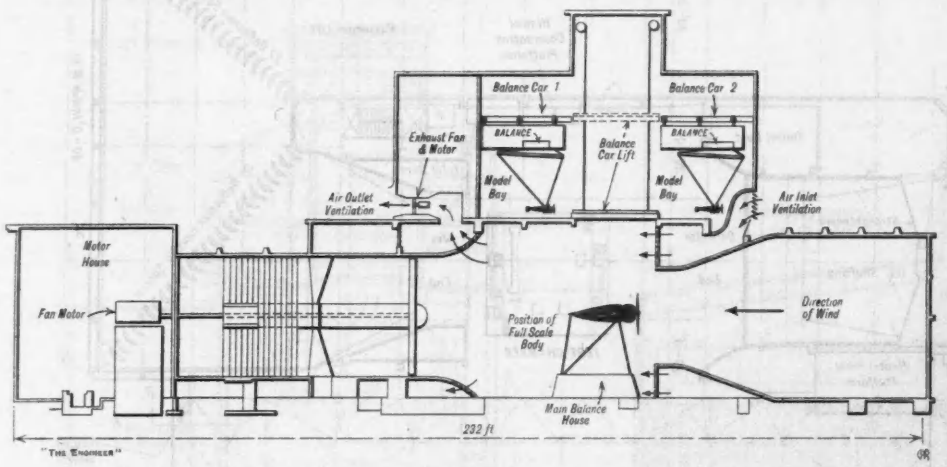


FIG. 11—DIAGRAMMATIC ARRANGEMENT OF THE TUNNEL AND SUPERSTRUCTURE

BRITISH WATERWORKS ASSOCIATION.

THE twenty-fourth annual general meeting and conference of the British Waterworks Association will be held at Cambridge from Tuesday, June 25th, to Saturday, June 29th, 1935. The Executive Committee of the Association will meet on Tuesday at the University Arms Hotel, Cambridge, at 6 p.m.

Delegates will meet on Wednesday at the Senate House, Cambridge, at 11 a.m., for the annual general meeting, after which the President will be installed and will give his presidential address. After luncheon (1 p.m.) in the Hall at King's and St. John's Colleges, the delegates will assemble in the University Lecture Rooms, Mill-lane, at 2.30 p.m. The following papers will be read and discussed:—"Water Softening at Cambridge," by Dr. E. V. Suckling and Mr. Philip Porteous; "The History of the Drainage of the Fens," by Dr. H. C. Darby; "Modern Methods of Management Control," by Mr. T. G. Rose; "Biological Research in relation to Water Supply," by Mr. Philip Ullyot. At 5.15 p.m. there will be an informal talk on "The University and Town of Cambridge," by Mr. P. C. Fitzgerald. A reception will be held in the evening at the University Arms Hotel by the Mayor of Cambridge at 8 p.m. On Thursday, at 10.30 a.m., parties will leave King's Parade and will visit the Cherryhinton water-softening station and the Fleam Dyke pumping station, where luncheon will be provided. After luncheon the delegates will return to Cambridge and make a conducted tour of the Colleges. At 4 p.m. there will be a garden party at Christ's College. At 6.45 p.m. the President will hold a reception at Trinity College, prior to the annual dinner at 7.15 p.m. At 9.30 p.m. an informal dance will be held at the University Arms Hotel. For Friday the following alternative visits have been arranged:—(*a*) To Newmarket and Ely; (*b*) to St. Germans middle level pumping station, King's Lynn and Ely; (*c*) local visits. A conversazione will be held at 8.30 p.m. at the University Engineering Laboratory. Provided sufficient applications are received, visits will be arranged on Saturday to Messrs. Eastwoods Cement Works at Barrington, and the works of the Cambridge Instrument Company, Ltd., and Pye Radio, Ltd. Further particulars may be obtained from the Secretary of the Association, Mr. G. P. Warner Terry, Grand Buildings, Trafalgar-square, London, W.C.2.

AT the general meeting of Pinchin, Johnson and Co., Ltd., it was announced that with another British company they are establishing a paint and lacquer factory in China.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE DOUGLAS SOCIAL CREDIT SCHEME.

SIR,—There must be many engineers who, like Mr. Willans, would welcome an impartial discussion, by engineers, of what is commonly known as "The Douglas Social Credit Scheme."

Fourteen years ago a book of mine was published in which I wholeheartedly supported the Douglas proposals. The *Church Times*, reviewing this book, was good enough to say that it contained the clearest exposition of these proposals issued up to that time. Since then, however, I have made a fairly exhaustive study of economics, orthodox and unorthodox, and can no longer endorse Major Douglas's views, though there can be no question that he and his followers have rendered great service by steadfastly emphasising defects in the existing monetary system.

It is not my intention to initiate here a discussion of technical flaws in "Social Credit" as expounded by Major Douglas and others, but I would like to make a few comments in general terms. Briefly, I consider that "Social Credit" enthusiasts claim far too much for their economic panacea, and are far too contemptuous of all views which do not harmonise with those of Major Douglas. As General Johnson recently said of Senator Huey Long's proposals, it is as though they claimed to have "a sort of economic hair-restorer, guaranteed to grow whiskers on a billiard ball," and at the same time warned everyone to beware of imitations. Many years ago Mr. H. G. Wells made one character say of another, a Socialist, in one of his novels: "He behaved exactly like a man in possession of valuable patent rights, who wants to be dealt with. He had an air of having a corner in ideas. Then it flashed into my mind that the whole Socialist movement was an attempted corner in ideas."

A similar attitude is adopted by "Social Credit" reformers. It is an attitude which drove me out of the Fabian Society long ago, and has always made me antagonistic to the claims put forward by the followers of Karl Marx—much as it invariably makes me sceptical of nostrums which are advertised as capable of curing all the bodily infirmities with which suffering mankind is afflicted.

This attitude—that all economic wisdom is embodied in the views of Major Douglas and his disciples—must alienate many who would otherwise be disposed to give these views sympathetic consideration. We all long for short cuts in life, and simple remedies for our ills, economic or otherwise: "Now the way from the river was rough, and their feet tender by reason of their travels; so the souls of the pilgrims were much discouraged because of the way. Wherefore still as they went on, they wished for better way. Now a little before them, there was on the left hand of the road, a meadow . . . called By-path Meadow. Then said Christian . . . here is the easiest going; come, good Hopeful, and let us go over."

Simple and unreflective people in particular are prone to believe in short cuts and universal remedies, a fact of which certain vendors of patent medicines are not slow to take advantage. It may not be without significance in this connection that the Douglas theory has made most headway in countries like Canada and Australia, among rural populations more accustomed to bodily than mental exertion. I am myself unable to understand how any serious student of history, of human physiology and psychology, can believe that there is one simple solution of the complex disharmonies besetting mankind to-day.

May I in conclusion make one more comment? There has been a tendency in recent years for engineers to study economics. This is all to the good. Nevertheless, I hold that ultimately our industrial troubles will be resolved not so much by economic as by psychological research. These troubles are moral rather than material. To quote a far abler writer than myself, Mr. R. H. Tawney: "The burden of our civilisation is not merely, as many suppose, that the product of industry is ill-distributed, or its conduct tyrannical, or its operation interrupted by embittered disagreements [or, we may add here, because there is a flaw in the price system]. It is that industry itself has come to hold a position of exclusive predominance among human interests, which no single interest, and, least of all, the provision of the material means of existence, is fit to occupy. Like a hypochondriac who is so absorbed in the processes of his own digestion that he goes to his grave before he has begun to live, industrialised communities neglect the very objects for which it is worth while to acquire riches, in their feverish preoccupation with the means by which riches can be acquired."

In short, what is required to put mankind on the right road is not a formula, but something far less simple; something from which those who seek short cuts turn impatiently aside. It is that complete change of heart, emphasised by Christianity, which so many Douglasites affect to despise.

HUGH P. VOWLES.

Wimbledon, April 4th.

EMPIRE DEVELOPMENT *V.* CREDIT SCHEMES.

SIR,—Does not the Douglas credit, and do not all such schemes for visualising true wealth as material and labour organised by brain, overlook the hard fact that the three salient laws of human existence have shown themselves unchangeable through the ages and in order of priority to be self-preservation, propagation of the species, and sense of property or acquisition? It is this last, I fear, which makes all such schemes merely the dream of sane and kindly, but Utopian, thinkers—the weakest has always gone to the wall and always will—until humanity suffers a sea change from within.

Engineers and inventors are going through a particularly bad time and are therefore in the right frame of mind to welcome any changes that would ameliorate their present lot, as recognition of the Douglas credit scheme, of course, would; but is not the hard road always the right road? It sounds priggish to say so, but I do not mean it that way, but merely ask if it is not so proved in the past. It seems to me that all civilised countries are in the same position. They are faced with overcrowding and are too civilised now to scatter into the undeveloped lands which would save the whole situation, just as we are too civilised to admit that war is another necessary evil of life. One feels that this country is in very real danger when one reads the hardening process that the youth of other European countries is undergoing, and that unless a virile streak underlies our apparent external softness, we will stand but a poor chance when "Armageddon" again rears its head in the "second round."

I cannot help thinking that temporary relief might be usefully found by public works, provided they are of an order such as really to improve the country, and that the Chancellor is wrong in hoarding credit as he is doing. I do not get the idea from Mr. Lloyd George, having voiced it for many years now; but in the end it is the natural law of supply and demand that must determine the position of all workers, brainy or brawny, and only by development of the vast overseas possessions we are neglecting can they again begin to function naturally, since the international markets are closed to us for ever and as judged by pre-war standards.

May I be permitted one example of which I have had personal experience? I allude to the herring trade; before the war the German and Russian markets enabled the herring fleet to earn a good return on capital and the workers to make a decent living. Ever since the war and the return to civil life of the splendid body of men that man this fleet the trade has been in difficulties. While help and palliatives are being tried the truth compels us to admit that till the fleet is worn down by attrition to supply the remaining demand and no more it must be a dud industry; but if it were found that the herring could be pressed to yield a useful fuel oil, for example, instead of having to get it from Persia or elsewhere, there would be room for twenty times the fleet.

The engineer is in similar case; until new lands demand new bridges, new railways, new transport, and the million products of his ingenuity, he too must face the process of attrition. There is a vast area of the world still to be made into a garden. Why do we not recognise that we own most of the suitable territory and get about it? The answer is that Westminster lacks vision, and now that the splendid opportunity just after the war has been let slip it is not so easy. Nevertheless, it will come again, and the Dependencies themselves who know that they cannot see the Mother Country go down and themselves survive will in time recognise that they must assist. But we need leaders who will set Empire development and all it means before all else, if we are to pull through the difficult years ahead.

S. P. CHRISTIE.

London, April 6th.

"DISPLACEMENT OF LABOUR": BANE OR BLESSING?

SIR,—It does not require that one should be a professional engineer to be exceedingly provoked by the letter of K. W. Willans on the displacement of labour by modern mechanical devices, the resulting problem of which he prefers to call "unempayment."

It would be a sad commentary on human wisdom if, as the burden of arduous labour is lifted, the only thing we could do was to limit the population to the diminishing number for whom life then provided *work* and *pay*. Yet that seems to be the drift of a letter to *The Times* on April 1st (!) by a Dr. McColl. To some of us that seems the ultimate blasphemy, the denial of life.

Can those who are ingenious enough to work out all these clever contraptions for the gladdening of life (by removing so much of its needless irk and strain) remain satisfied with such frustration of their gifts to mankind? And will they not refuse to acquiesce in an order of things which systematically frustrates the work of the scientist and engineer because of some prior loyalty to the gods of gold or monetary orthodoxy? As witnessing that so to state the case is not extravagant, instance the recent scientific debate between Dr. A. S. Russell and Dr. C. P. Snow, of Oxford and Cambridge respectively.

After some discourse on the structure of the crystal and the lay-out of atoms in different substances, it was made clear that now it is possible to "put atoms here and there in the crystal so that the material made up of those crystals can have any property you want it to have"! . . . "We have got the recipes," said Dr. Snow. "We have got the raw material, and we have the necessary equipment to turn it into the finished stuff. . . . We know a good deal about the arrangement of the atoms in natural fibres now. . . . It is not a long step to take a material like wood, which contains cellulose, and make a light and porous material from it by chemical methods and make it into clothes. It would be very light, very comfortable, perfectly fitting (without tailoring), very warm, and . . ." No, it is not a case of those very enticing goods we covet, but which are priced at a prohibitive figure. The trouble here is the very cheapness of the outfit. The lecturer went on to declare "A shilling would give you a nice suit!"

From clothes they went on to houses. "A new material, lighter than cork, extremely strong, heatproof, soundproof," is available. "Think of the buildings you could make, light, and strong, and beautiful. We should have a renaissance of architecture! The stuff is there waiting for us; it is made; the scientists have done their bit." Where is the snag, then, that for the most part we continue in frowsy gear and in very unideal houses?

"The difficulty," continued Dr. Snow, "is that the material might be too cheap. . . . The old story. Labour and Capital displaced by new inventions. Old factories and foundries made obsolete. Economic difficulties (evidently meaning financial difficulties). But that isn't a scientific problem!!! That is someone else's pigeon." A reply that would hardly be satisfactory if, after first designing a Rolls Royce motor, one found that because petrol was so cheap one were not allowed to operate it.

Surely it needs only an extension of the truly scientific spirit applied to the matter of our industrial and financial system to devise such an adjustment of our monetary mechanism that the product of Nature and human ingenuity can be enjoyed.

The persistent frustration of the fruits of science must tend toward the unbalancing of the human mind. We were not meant to be shut up to such futility.

Major Douglas's Social Credit proposals embody a technique devised to ensure that the work of the scientists, engineers, and discoverers *is conserved*, and becomes reflected in the growth of the welfare of the community. Major Douglas has long invited the most searching examination of his analysis on strictly scientific principles. What he does not welcome is the spurious inquiry which is voided by the *a priori* acceptance of unscientific assumptions which preclude any very radical change.

Maryport, April 3rd. PERCY JACKSON.

THE "SHARPAFORM" CUTTER.

SIR,—We have read with interest the article in your March 22nd issue of THE ENGINEER, on "Stag Sharpaform" cutters. You say: "'Stag Sharpaform' tools are made with what is termed corrected straight line relief. Referring to the sketch, which shows two teeth of a cutter, it will be seen that each tooth is formed with a flat top." In point of fact "Stag Sharpaform" cutters and hobs can be made with teeth with flat tops, but it is not our intention to produce tools with theoretically flat tops to the teeth. Actually this particular form of relief is generated along what is termed a straight line directrix or rectilinear directrix, which can be placed outside the tooth, on top of the tooth, or in any other desired position. It is our intention, generally speaking, to place the straight line directrix somewhere in the form of the tooth, the exact location depending upon certain technical considerations. If the straight line directrix is so placed, the top of the tooth will have a slight curvature, which, while hardly perceptible, is, nevertheless, there, and we should like to state at once that this slight curvature is not detrimental in any way, and actually has certain advantages, inasmuch as a closer ratio of relief from the front to the back of the tooth can be obtained.

The other point to which we should like to draw attention is the statement in the article inferring that the maximum number of full-length teeth which can be placed in the cutter is twenty. This, of course, is not correct, and we think your contributor has overlooked the very important fact that it is customary to make the gash between the teeth approximately one-third of the distance from point of the first to point of the next tooth, and not one degree, as stated. From this fact it will be at once apparent that the number of teeth on a cutter is not controlled in the manner stated.

We would also like to point out that the normal size of gash we have mentioned never allows the angular clearance on the actual teeth to depreciate below approximately seven degrees, which is a very important point.

In conclusion, we should like to state that for certain types of tools we adopt as a standard practice what may be termed double relief. This gives an even greater average of angle clearance, with a very strong tooth, which is an admirable feature for certain operations.

EDGAR ALLEN AND CO., LTD.,
R. G. WOODWARD, Director.

Sheffield, March 28th.

HIGH-SPEED RAILWAY RUN.

SIR,—Neither in the article in your issue of March 15th nor in subsequent correspondence on the record run of "Papyrus" on the London and North-Eastern Railway on March 5th, has any doubt been cast on the accuracy of the maximum speed of 108 m.p.h. which is claimed for this run. While I do not wish to detract in any way from the credit which is due to the London and North-Eastern Railway, and, more particularly, to Mr. Gresley, for their magnificent and record-breaking achievement, yet I feel that it is only right that the closest scrutiny should be given to the figure claimed for maximum speed on an occasion of this kind—which may well become historic—before such figure is accepted as correct.

The speed diagram reproduced with your article showed

a speed which remained fairly steady at 105 or 106 m.p.h. for some miles with a short hump in the curve to 108 m.p.h., the length of this hump being not more than half a mile. In this half-mile the speed must therefore have risen from 106 to 108 m.p.h., and fallen again to 106 m.p.h., so that the rise of 2 m.p.h. was achieved in a distance not exceeding a quarter-mile, *i.e.*, in a time of about 8½ seconds. The rate of acceleration was therefore 2 m.p.h. in 8½ seconds, or 14 m.p.h. per minute. Is this possible?

I have frequently timed the "Cheltenham Flyer" out of Swindon, and find that a little over 4 minutes is required to reach 60 m.p.h., so that the acceleration is not more than 15 m.p.h. per minute over the speed range in which the locomotive is able to develop its maximum drawbar pull. It hardly seems possible that "Papyrus," even aided by a falling gradient of 1 in 200, could have achieved the same acceleration when hauling a train at 105 m.p.h. Mr. Gresley and his technical assistants must doubtless have considered this point carefully, and it would be of great interest to know their conclusions.

There is one point which appears to me to be rather striking. The speed of 100 m.p.h. claimed for the previous run from Leeds in November last was obtained by just such another small hump on the speed curve, and the hump in both cases was exactly centred on the 91st mile-post from King's Cross. It is difficult to see how the accurate and simple method of speed recording which was employed could be in error, but I should like to ask whether it is possible that there can be some feature of the track at this particular spot which introduces a temporary small inaccuracy in the record.

J. S. Dines.

London, S.W.1, April 6th.

SOCIAL CREDIT.

Sir,—Subsequent to your publication of M. Jenny's article I wrote commending your action and suggesting that you should allow an exponent of Social Credit to reply thereto. From your courteous reply I gathered that you felt the use of your space would not be warranted in view of the fact that the Major's views had already been published elsewhere.

May I, therefore, express the pleasure which I and many colleagues feel at reading in this week's issue a letter on the subject from Australia, and offer you our thanks for the additional space afforded to two other letters on this subject? When Major Douglas addressed the Engineers' Institute in Glasgow a few weeks ago, he had an audience of about 700 who paid the closest attention to his address on "Production and Distribution," and I know that considerable discussion has followed in drawing offices and similar places since.

There is no doubt that the Major has raised Economics to the position of an exact science by his mathematical treatise to the consternation and confounding of *Professional* Economists.

Perusal of a wide range of newspapers and periodicals shows that at last it is being recognised that readers want news and opinions, and explanations of this idea, which offers to free mankind from *artificial* scarcity.

When the Major addressed the Merchants' Club in Oslo a month or so ago, the King of Norway and the Prime Minister were in the audience.

Engineers have bequeathed a legacy to mankind which potentially can supply his wants in unlimited abundance, and all their instincts are tuned to continue this service.

Their efforts are continually frustrated by a financial system which withholds these benefits and then *insists on their destruction* in the midst of want and poverty. How can we neglect to turn our attention to this agency which deprives mankind in general of that which we have to offer and deprives *us* of developing and enjoying our profession to the limit of our abilities?

The responsibility of Editors is acknowledged to be great. In the days to come it will be recognised that the greatest were those who turned men's eyes to the "New Economics."

C. W. Ryden.

Glasgow, April 8th.

STREAMLINING.

Sir,—Your excellent leading article on this subject (March 22nd) well emphasised the need for exercising caution before necessarily accepting as correct any new theories respecting the atmospheric—or, for that matter, any other—component of train resistance.

Mr. Dendy Marshall's contention—that the effect of a side wind is a negligible factor—is certainly contrary to all preconceived ideas concerning the running of trains. Sir Henry Fowler happened specifically to refer to this phase of the question in his paper on the "Consumption of Fuel in Locomotive Practice," read before the British Association in 1930. He stated: "The wind also has a very considerable influence on the power demanded. This is more marked, however, in the case of a side wind than a head wind. This is due to the fact that a side wind tends to drive the whole train over against one rail, increasing materially the flange friction against this rail." That view is the one that has always been accepted.

There is on record, indeed, an instance in which, about thirty years ago, a thirteen-coach train on an Indian metre-gauge railway was blown bodily over by the force of the wind. Would Mr. Dendy Marshall argue that that train was not pressing against the lee rail?

Incidentally, this Indian case has an indirect bearing on streamlining, although the train was in no way streamlined. The inference to be drawn from it is that the greater the superficial area exposed to the action of the air, the greater the resistance will be; consequently, the complete boxing-in of the locomotive and coaches as one unit cannot be as beneficial as theory—and calculations—would appear to indicate. In the Canadian wind tunnel tests (Canadian National Railways, 1932) it was proved that the attempts to reduce the air resistance of a train by closing the gap between the engine and tender, and the spaces between the coaches, were absolutely useless.

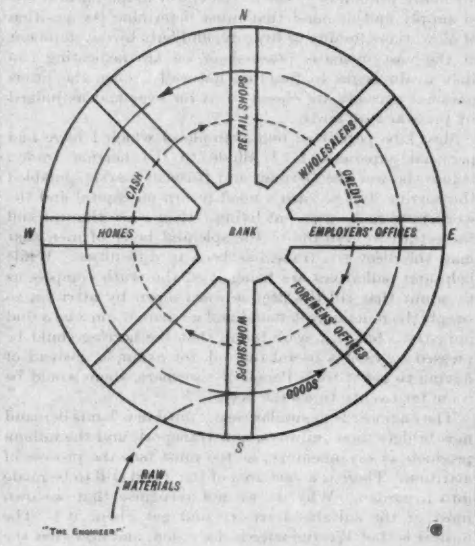
In February, 1904, Henschel and Son built a 4–4–4 high-speed, three-cylinder compound, of the wholly enclosed type for the Prussian State Railways. It was supposed to reduce atmospheric resistance to the equivalent of 250–300 h.p.; but whether this potential advantage was ever attained in actual practice or not, the fact remains that, in a general sense, the idea fizzled out at the time.

F. W. Brewer.

Stevenage, Herts, April 8th.

THE CONSUMER.

Sir,—With reference to Mr. Allen's letter, the enclosed diagram seems to bring out a number of economic facts. Suppose that the enclosed diagram represents a town with four main streets radiating from the centre: West-street, North-street, East-street, and South-street. All families live in West-street, all retail shops are in North-street, all employers of labour are in East-street, and all workshops are in South-street. The housewife will go with her money and orders, in a clockwise direction, to North-street to shop. She will bring back the goods purchased in an anti clockwise direction and redistribute them when she gets home as meals, &c. The worker, after eating his meal, will go anti-clockwise to South-street, to work, using the potential energy in the meal to redistribute materials. He



will come back to West-street with his wages. The orders in the retail shops will be redistributed between various wholesalers in, say, North-East-street, who will redistribute them between the various employers of labour in East-street. These will be redistributed to the various foremen who have their offices in South-East-street, who will redistribute them again to the various individual workers in South-street.

It will be noticed that money, orders, and credit (power to give an order) always flows clockwise, and goods always flow anti-clockwise. The system is absolutely democratic, as the housewife has the power to choose the shop that gives the best value. The same power rests with each of the other agents in the cycle.

The forward E.M.F. of money and credit will equal the back E.M.F. of goods. If the system is upset there will be more goods produced than there is power to consume them, with the result that manufacture will have to slow down.

The Government represents the interests of the citizen as a worker and is in West-street. The employer controls the worker in the interest of the citizen as a buyer. If the bank is placed in the centre of the town, cash from retailers will pass straight downwards to the workshops to be paid in wages, a balancing stream of credit passing upwards.

April 5th. J. H. Williams, M.I. Mar. E.

THE POWER OF THE CONSUMER.

Sir,—It is just a question how far discussion of means may be helpful in achieving ends desired by everyone. I refer to the correspondence in your columns which discusses suggested amendments of the financial methods of distributing the products of industry to the consumer.

There is no question at all that everyone wants to consume more, or, at least, wants to see more consumed, of the output of industry, which at present is choked with unmarketable goods—unmarketable, not because undesired, but because of a chronic and apparently growing insufficiency of effective incomes, or purchasing power, in the hands of individuals. These are obvious facts.

What, then, can engineers, as engineers, do about it? Nothing much, I fear. The business of engineers, like all other experts and technically qualified persons, is to devise means to specified ends; but those who specify the ends are not the experts, but the powerful interests who can command the experts to achieve those ends.

What are the interests that desire the end of ability to consume the abundant output of modern industry? Surely the consumer—the man in the street. And, in a democracy, he derives his power from the vote. Until he exercises this power of the vote—until he clearly expresses by means of the vote his will to have a higher effective income—it is merely academic to discuss the *means* by which his will for this *result* can be achieved.

London, W.C.1, April 8th. L. Patterson.

HIGH-SPEED WIND TUNNEL.

Sir,—I have read with interest the article entitled "The Twenty-four Foot Wind tunnel at Farnborough," which appeared in your issue of April 5th, but should be glad if you will allow me to draw attention to a statement which appears to be rather misleading.

It is stated on page 351 that "to compensate for the one-seventh scale of the model purely by adjusting the velocity we would have to test the model in a current of seven-fold speed, or at 1400 m.p.h. This speed is far beyond what can be realised in any wind tunnel." We would like to point out, however, that the late Sir Thomas Stanton produced a high-speed wind tunnel, giving speeds up to about 3½ times the local velocity of sound in air (equivalent to over 2200 m.p.h. in free air), and that this has been in use for some years in this department of the National Physical Laboratory. A description of the tunnel is given in the "Proceedings" of the Royal Society (A), Vol. 131, 1931.

The theoretical speed of a wind tunnel would appear to be limited only by the limiting rate of flow of the working fluid into a vacuum. By raising the initial pressure of the fluid, the limiting speed can be raised far above the speed of sound.

H. Gough, Superintendent.

The National Physical Laboratory,
Engineering Department,
Teddington, Middlesex,
April 6th.

[We are much obliged to Dr. Gough for calling our attention to this interesting tunnel. It is, we learn, 3in. in diameter and is used for a variety of experimental purposes. It should not be inferred from Dr. Gough's letter that this tunnel provides in general a means for testing small aeronautical models at extremely high speeds and thereby realising Reynolds numbers equal to those for full-scale conditions. As the wind velocity in the tunnel is about 3½ times the velocity of sound in air the compressibility of the air would dominate the results of a test on, say, an aerofoil whereas in the case of a full-scale wing moving at a normal flying speed the compressibility effect is absent or negligible. Hence although the Reynolds numbers for the model and full-scale conditions were equal, the conditions would not be comparable and the model test results would be inapplicable to the full-scale wing. The tunnel might, however, be used for tests on model propellers, for some full-scale airscrews approach or reach a tip speed equal to the velocity of sound in air. Since the compressibility of the air affects in this case both the model and the full-scale conditions, the model test results would, to a certain extent at least, be applicable to the full-scale body.—Ed. The E.]

STREAMLINED TRAINS.

Another light-weight high-speed motor-driven articulated train has been put in service on an American railway. Unusually large patronage of such trains is being reported, but whether the number of passengers will continue when these trains cease to be a novelty must remain for the future to show. The new "Flying Yankee" of the Boston and Maine Railroad is a three-car articulated train carried by four bogies and weighing in all about 106 tons, of which the engine and power equipment represents about 52 tons. Its total length is 200ft. The first car has the engine-room, a baggage compartment, lunch room, and seats for twenty-eight passengers. The second car seats sixty passengers and the third car fifty-six passengers, including twenty chairs in the rear observation room. A 600 h.p. high-compression, two-cycle, eight-cylinder oil engine drives a generator furnishing current to the axle motors. An auxiliary generator serves the air conditioning system, the lights, cooking equipment, and controls, and also charges the storage battery which is used for starting the engine. The weight of engine is about 22 lb. per horse-power, this weight being largely reduced by the use of welded steel plate to form the engine block, crank case, and cylinder block in one piece. The crank shaft is carried in nine main bearing seats on transverse members cut to four frames for the fabricated engine block. The engine bed-plate is also of welded steel plate and built up to form also the buffer plate and the bolster for the driving bogie. For this unit the plates are of an alloy of chromium, manganese and silicon, having 90,000 lb. tensile strength, 70,000 lb. elastic limit, and high resistance to shock and fatigue. It weighs about 3½ tons. To the cylinder heads are bolted the water-jacketed cylinder liners, made of heat-treated cast iron. Oil circulation cools the aluminium alloy pistons and with four exhaust valves to each cylinder only a minimum blower pressure is required for the scavenging. The cars are of stainless steel, with flexible diaphragms between them, flush windows and enclosed steps, so as to form a continuous smooth surface to reduce air resistance.

Rail and Road.

It is officially announced that Mr. H. F. D. Page, who now ranks as assistant to the signal engineer, has been appointed the assistant signal engineer, Great Western Railway, Reading.

The railways of the United States have been given permission to increase temporarily their rates, so as to bring in 85,000,000 dollars. They asked for a 10 per cent. increase, which would have produced 172,000,000 dollars.

The L.M.S. Railway announces the introduction of further high-speed passenger schedules commencing with the spring time table, which comes into force on Monday, April 29th. Three new timings at average speeds of over 60 m.p.h. start-to-stop will be brought into operation, raising the total daily mileage in this category to the record figure of 1235 miles per day.

Railwaymen, with eighty years' use of the terms behind them, may be forgiven for still referring to "Board of Trade" inspections of railways and "Board of Trade" inquiries into accidents, forgetful that the Ministry of Transport is now the authority over railways. We would have expected, though, that Sir Samual Hoare would have been better coached than, when speaking on the India Bill on April 1st, he said: "Here, the Board of Trade was the Department responsible for safety on the railways."

The report for 1934 of the Great Southern Railways of Ireland shows that the gross receipts from railway working rose from £2,871,912 in 1933 to £3,033,166; but this was accompanied by a rise in expenditure from £2,566,596 to £2,719,845. The latter increase mainly was owing to maintenance of rolling stock advancing from £432,642 to £502,921. The ratio of working expenditure to receipts was 89·97, as against 90·65 in 1933. Goods traffic produced 58·56 per cent. of the traffic recipts, as compared with 57·02 per cent.

The Ministry of Transport held ten inquiries into train accidents last year. All related to collisions between trains; there were no bufferstop collisions inquired into, nor derailments. Five were collisions between two passenger trains; one was a light engine and a passenger train; one a passenger train and a standing freight train, and one related to a light engine and a rail motor trolley. The other two cases were those of passenger trains striking road motor vehicles, and in one of these derailment followed. In one of the collisions between passenger trains, six passengers and three servants were killed, and in another ten passengers and one servant lost their lives. One servant in the motor trolley accident was killed, and two servants in the derailment just mentioned.

With the object of making some fitting contribution to the national expressions of rejoicing at the completion of twenty-five years of their Majesties' reign, the London, Midland and Scottish Railway submitted to H.M. the King the request that it might be permitted to bestow upon one of its latest express locomotives the name "Silver Jubilee." His Majesty has graciously consented to this proposal, and the name "Silver Jubilee" is accordingly being given to engine "No. 5552," the first engine to be built at Crewe Works of the latest L.M.S. express passenger type. This class of engine, of which thirty are being constructed in Jubilee Year, will be known as "the Jubilee class." It is of interest to note that the L.M.S. already has an engine, "No. 5348," named "Coronation," which was constructed at Crewe Works in 1911, the year of their Majesties' Coronation.

The "Review of the Company's Business During 1934" that accompanied the L. and N.E.R. annual report for last year said, as to the electrification of the Great Eastern section, that the total expenditure involved would amount to £7,000,000, and no adequate return could be expected on the outlay. The existence of keen competition by road, and the possibility of competition by tube in other hands, had also to be considered, as such competition would have effectually destroyed any prospect of ultimate fructification of the expenditure. The possibility of a tube scheme was also investigated, but here again the expenditure involved was heavy and the net return negligible. The Board came to the conclusion that, in the absence of a pool of competing interests and of substantial Government assistance, electrification of the Great Eastern suburban lines could not be other than a losing proposition. They accordingly turned their attention to the improvement of the existing steam service, within the limits of what was financially possible.

It was thirty-five years ago on April 1st since the Coulsdon-Earlswood line was opened. The necessity for it makes some interesting railway history. The original section of the London, Brighton and South Coast Railway—formed in 1846—was the London and Croydon, opened in 1838. The London and Brighton, authorised in 1837, was to run from a junction on the London and Croydon near Norwood. The South-Eastern had been given powers in 1836 to build a line to Dover, which also was to commence from the London and Croydon. Parliament would not sanction the apparent extravagance of two such parallel railways, and decided that it should be a jointly owned line. Its working was always a bone of contention between the L.B. and S.C. and the S.E.R., and led to a wearisome business known as the Southern Lines Controversy. Eventually the dispute was referred to the arbitration of Sir Henry Oakley, the then general manager of the Great Northern Railway. His award, made in July, 1889, was so much in favour of the South-Eastern that the L.B. and S.C. lost between £5000 and £6000 a year; but Laing, the chairman, said that "the advantages of peace were very cheaply purchased at that price." Despite that, the Brighton Company decided in 1893 that it must have its own line, and powers were obtained in 1894. On it is the Merstham second tunnel, 2113 yards long. The line was designed by Mr.—now Sir—Charles L. Morgan, who became the chief engineer of the London, Brighton and South Coast Railway on February 1st, 1896, and who, among other subsequent big works, was responsible for the enlargement of the Brighton terminus at Victoria and of its approaches, including Battersea railway bridge. Sir Charles is now a director of the Southern Railway.

Miscellanea.

The number of vehicles using the Mersey Tunnel is well in advance of the estimated monthly average. Last month 153,615 vehicles passed through, compared with a monthly average of 132,500, estimated two years before the tunnel was opened.

It was recently stated in the House of Commons that 103,700,000 tons of coal, representing 47 per cent. of the total coal output for 1934, were cut by machine. The corresponding figures for 1913 were 24,400,000 tons, or 8 per cent. of the year's output.

The Scottish correspondent of the *Chemical Trade Journal* reports that a company is being formed to erect a plant at Garnkirk, Lanarkshire, at a cost of £400,000, for the production of smokeless fuel, oils, and gas as by-products. It will have an annual output of 130,000 tons of smokeless fuel, and 315 million cubic feet of gas by-product.

Two new types of electrical manometers are described in the recently issued Safety in Mines Research Board Paper No. 91 by Messrs. G. Allsop and H. Lloyd. The apparatus is not limited to the measurement of pressures only, but can be used to detect and record small displacements of condenser plates, no matter how they are caused. The circuits used are electrically stable, the sensitivity is readily adjustable over a wide range, and the constants of the circuits have been chosen so as to eliminate distortion due to the recording circuit.

Digging holes for transmission poles where there is a large amount of water in sandy soil is a difficult job, and in the *Electrical World* Mr. F. Clayton describes a successful method whereby dynamite is used. A short piece of 1¼in. iron pipe, flattened on one end, and threaded on the other, is screwed loosely on to a longer pipe of the same size and driven down a little deeper than the hole is to be made. While the long piece is still screwed to the short one, about one-half stick of dynamite is lowered into the short piece of pipe by means of ignition wires. The long pipe is then unscrewed and raised, leaving the ignition wires in place. With the latter protected by a board against the side of the hole, the pole is set up over the small driven hole and held by guy ropes in an upright position. When the dynamite is detonated, the pole will jump up a foot or more as the sand is discharged, but will drop back into the hole before it fills up. The pole can then be straightened and the earth tamped.

In a paper on "The Materials of Construction for Chemical Engineering," Mr. J. McKillop described the electrical method of testing enamelled vessels. In this test the vessel is filled within an inch or two of the top with a salt solution consisting of 1 lb. of salt to each 45 gallons of water. A metal filament, gas-filled, plain glass electric lamp of capacity determined by the size of the vessel, 60 watt for vessels up to 250 gallons capacity and 75 watt for vessels of greater capacity and up to 450 gallons, is connected to a 240-volt single-phase A.C. 50-cycle supply, and from the other pole of the lamp an exploring lead is suspended in the salt solution. A lead from the pan body is connected to the neutral of the A.C. supply. The enamel lining to be tested is thus subjected to a supply pressure of 240 volts, and any excessive current leakage will be indicated by the glowing of the lamp. For a successful test the lamps specified above must remain black, when observed under darkened conditions. The surface of the enamel above the water level must be dried carefully, for quite a small film of moisture is sufficient to cause leakage enough to light the lamp and so give rise to the false conclusion that the lining is faulty.

The Government of Bombay has decided to commence the building of two new bridges in the presidency this year, one of which will cost approximately Rs. 4½ lakhs and the other about Rs. 60,000. Both will be of the submersible type in accordance with the new policy of Government to build this type of bridge where bridges are required on all roads except Indian trunk roads. Formerly bridges were designed to pass all flood waters under them, which meant that they had to be raised to such a height that the highest flood would pass underneath. Examination of the actual value of bridges of such a height showed that in some cases the floods tested them to capacity perhaps only once in 100 years. To provide for this rare occasion the original cost of the bridge was at least more than double the type now proposed. The first bridge will be 975ft. long, built in fourteen spans and will be of reinforced concrete costing about Rs. 4½ lakhs instead of Rs. 10 lakhs, which would have been required for a high flood level bridge. The second bridge to be begun this year will be of the same type, but on a much smaller scale, to cost, including the cost of approaches, about Rs. 60,000. It is to bridge the river Kukri on the Poona-Nasik road, 53 miles from Poona, and near the village of Pimpalwandi.

An investigation on fog dissipation by chemical means has been made in America by Professor E. L. Bowles and H. G. Houghton, and in the report given before the American Philosophical Society, they stated that in their experiments it was found that a gramme of calcium chloride powder was capable of clearing about 3 cubic metres of specific fog air at 20 deg. Cent. This result indicated that dissipation was due to a lowering of the vapour pressure and not to a physical sweeping action. Thus with a relative humidity of 97 per cent., drops of 40 microns diameter evaporated completely in thirty seconds. When the relative humidity was lowered to 85·6 per cent., drops of 50 microns in diameter evaporated in ten seconds. Investigations showed that small drops of calcium chloride removed more water vapour than large ones. A practical test was made on an actual fog using a 100ft. pipe fitted with the special nozzles at frequent intervals and suspended 30ft. above the ground. When the fog had completely enveloped the region, limiting the visibility to less than 300ft., a fine spray of calcium chloride solution issued from the long pipe. Fog drifting through the chemical curtain began to precipitate, falling to the ground in the form of water drops. Within a few minutes objects more than 2000ft. away were clearly revealed along a path 100ft. wide and 30ft. high. This path was clear so long as the spray was operated.

Air and Water.

On April 7th the first mail for South America to be carried all the way by air from France left Le Bourget at 12.51 a.m., and arrived in Brazil at 7.43 p.m. on April 8th.

An international aero show is to be held for the first time in Portugal. It is being organised by the Aero Club of Portugal and will be held in the Exhibition Palace at Lisbon from June 1st to June 15th next.

The annual report of the Royal Aero Club shows that 1168 new "A" licences were taken out last year, and 137 new "B" licences. At the end of the year current licences numbered 2979 "A" and 498 "B." There were 90 gliding certificates issued during 1934.

The record height of 129,855ft. was reached by an automatic stratosphere-sounding balloon released recently by the Moscow Hydrological Observatory. At this height a temperature of 51 deg. below zero was recorded; the greatest cold registered was at 33,790ft., when it was 76 deg. below zero.

The Belgian Air Lines (Sabena) have put into service three new Savoia Marchetti air liners. Capable of carrying eighteen passengers, the machines each have three Gnome-Rhone 600 h.p. engines, giving them a top speed of 210 miles an hour, and a crusing speed of 180 miles an hour, with a range of 620 miles.

The success, following the arrangement for sending aeroplane mails from the "Europa" and "Bremen," with the German Post Office, Luft Hansa, and N.D.L., has led to a full resumption of the service this coming season. The catapult aeroplane flights to and from ports will open on May 3rd, when the "Bremen" leaves Bremerhaven for New York.

The performance figures of the new Boulton and Paul "Overstrand" medium bomber have been issued. Driven by two "Pegasus M" type radial engines, the machine has a maximum speed of 152 miles an hour at 5000ft., and is capable of flying 135 miles an hour at a height of 20,000ft. Take-off and landing runs are very short, and the machine stalls at 54 miles an hour.

Air training is to be introduced into the syllabus of the training ship H.M.S. "Conway." The new course will include theoretical and practical instruction in aviation. Flying and engineering instruction is to be carried out at the Liverpool and District Aero Club, and each cadet will receive a minimum of fifteen hours' instruction in the air—sufficient to enable him to obtain a pilot's "A" licence.

A new air mail service from London to Paris has been inaugurated. Letters addressed to Paris may now be posted in London as late as 1 a.m. and will be delivered in Paris by the first morning post. This night mail, operated by Air France, will connect with a new air service from Paris to Lyons, Geneva, Marseilles, Barcelona, Corsica, Tunis, the Balearic Islands, and Algiers. Delivery will be made to all these places the same day.

A net tonnage of commercial shipping of 31,750,802 passed through the Suez Canal during 1934, as compared with 30,676,672 tons in 1933. Of the former total, 54·3 per cent. were British vessels, 9·4 per cent. German, 8·1 per cent. Dutch, and 6·6 per cent. Italian. Through the Panama Canal, the traffic totalled 28,970,590 net tons, as against 25,251,759 tons in 1933, of which 12,998,734 tons were of United States nationality. British vessels accounted for 7,024,920 tons, and Norwegian 2,499,559 tons.

Amongst interesting ships now under construction is a group of three ships for the German subsidiary of the Unilever Company. These vessels are intended for trade to West Africa, and will be large cargo vessels with steam reciprocating engines taking steam from Scotch boilers. Particular interest is centred on the hulls, which will be constructed with Maierform lines. The three cargo steamers are each of 8000 tons deadweight carrying capacity, and are under construction at the yards of the Deutsche Schiff und Maschinenbau A.G. at Bremen and Bremerhaven.

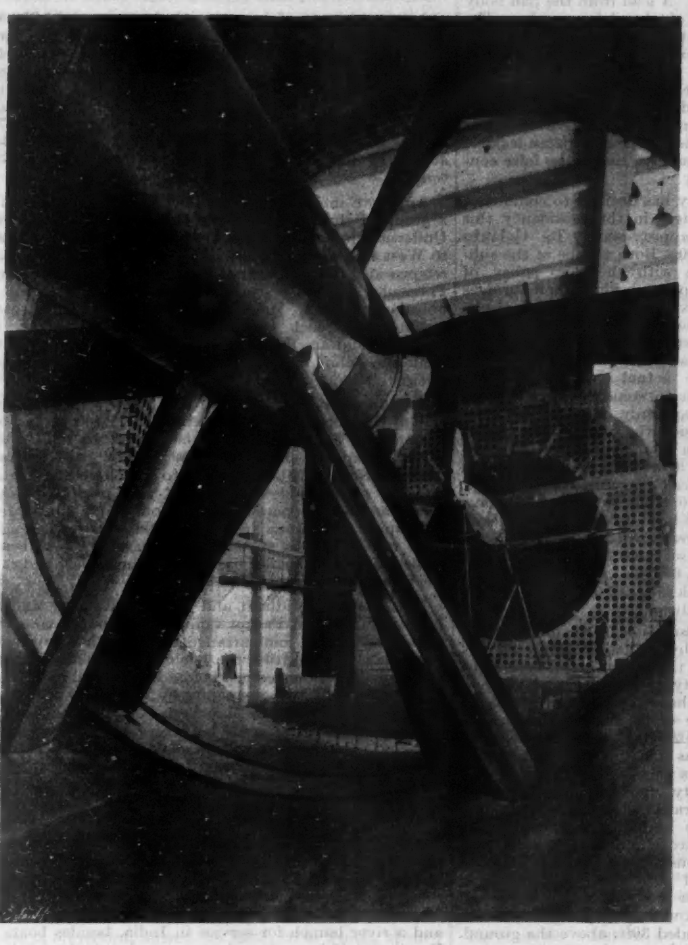
The transfer of the British naval station to the Arab side of the Persian Gulf is welcomed. The large and cool promontory at the north-east corner of the main island of the group was purchased last year by the Admiralty from the Sheikh. It is adjacent to a sheltered anchorage, and the site includes gardens, a good supply of fresh water, and ample space for recreation, and is 3 miles from the capital, Hanjam, from where the native station has been transferred, is an arid and almost deserted island, while Bahrein is fertile, has modern amenities, and is on the Imperial Air route.

The London, Midland and Scottish Railway and the Isle of Man Steam Packet Company announce that they have entered into joint arrangements for the provision of air services to and from the Isle of Man. These services, which are to commence just before Easter, will be operated on behalf of the two companies by Railway Air Services, Ltd., and will connect at Manchester or Liverpool with the existing R.A.S. trunk route between London, Belfast, and Glasgow. Connections will be made at Croydon with the Continental services radiating from that point, while by other connections with R.A.S. services air transport will be later available to and from the Isle of Man and the South Coast and West of England.

As in previous years, John I. Thornycroft and Co., Ltd., arranged recently a demonstration of motor boat construction at its Hampton Yard on the Thames. Amongst the vessels being completed for abroad there is a 35ft. launch for the Palestine Government, for use at Haifa, and a river launch for service in India, besides boats for Brazil and China. Vessels now on the stocks for home waters include three 45ft. motor yachts equipped with 60 b.h.p. and 80 b.h.p. Thornycroft engines, while other ships now being built include cruisers of 30ft. and 45ft. length. The demonstration was of particular interest, as it showed how Thames craftsmanship in fine boat-building has been successfully applied to the design and construction of modern craft propelled by internal combustion engines.

THE R.A.E. 24-FOOT WIND TUNNEL, SOUTH FARNBOROUGH

(*For description see page 380.*)



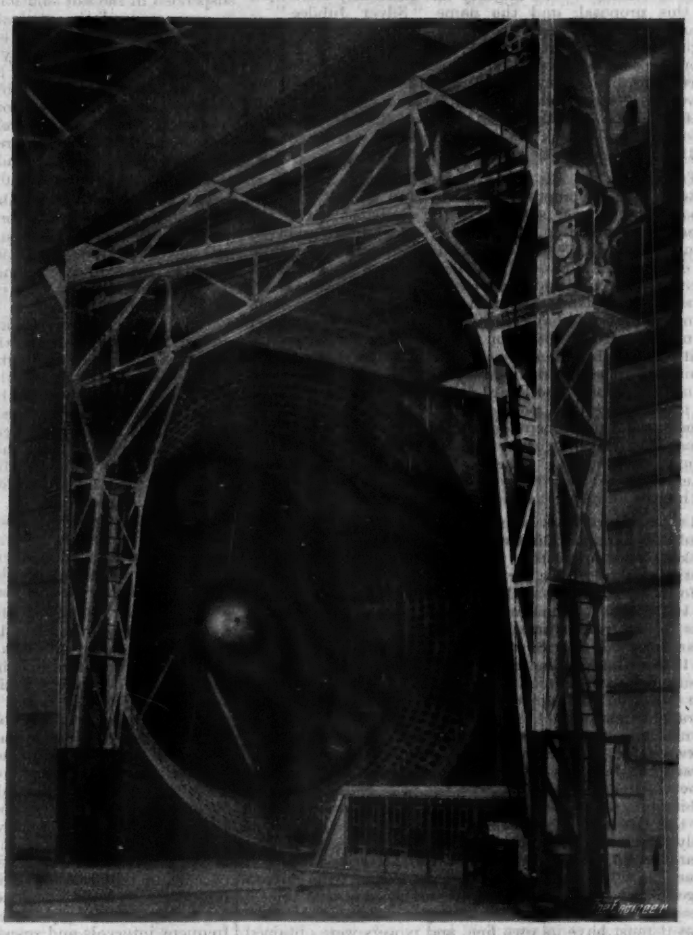


Fig. 13 (Above):—Collector End Showing Straightening Fins

Fig. 14 (Below):—The 30-Foot Fan

Fig. 15 (Above):—Model Balance Carriage and Lift

Fig. 16 (Below):—Collector End and Jib Cranes

The Engineer

APRIL 12, 1935.

VOL. CLIX. No. 4135

Contents.

THE ENGINEER, April 12th, 1935. PAGE

A SEVEN-DAY JOURNAL ... 373
THE DEVELOPMENT OF PARSONS INDUSTRIAL TURBO MACHINERY. No. XIV. (Illus.) ... 374
AUTOMATIC SYNCHRONISING EQUIPMENT. No. I. (Illus.) ... 377
RESEARCH INTO CAST AND MALLEABLE CAST IRON ... 379
AMERICAN AVIATION POLICY ... 379
THE TWENTY-FOUR-FOOT WIND TUNNEL AT FARNBOROUGH. No. II. (Illus.) ... 380
BRITISH WATERWORKS ASSOCIATION ... 382
LETTERS TO THE EDITOR—
The Douglas Social Credit Scheme—Empire Development and Credit Schemes—"Displacement of Labour": Bane or Blessing?—The Sharpaform Cutter—High-speed Railway Run ... 383
Social Credit—Streamlining—The Consumer—The Power of the Consumer—High-speed Wind Tunnel ... 384
STREAMLINED TRAINS ... 384
RAIL AND ROAD ... 385
MISCELLANEA ... 385
AIR AND WATER ... 385
LEADING ARTICLES—
Aeronautical Research ... 387
Transmission Line Insulators ... 387
INSTITUTION OF NAVAL ARCHITECTS. No. I ... 388
NEW P. & O. LINER "STRATHMORE." (Illus.) ... 389
METAL-CLAD SWITCHGEAR. (Illus.) ... 390
A NEW OIL PURIFICATION PROCESS. (Illus.) ... 390
SOUTH AFRICAN ENGINEERING NOTES ... 391
SIXTY YEARS AGO ... 392
HIGH-PRESSURE MARINE BOILERS. (Illus.) ... 393
CONVENTION OF THE AMERICAN RAILWAY ENGINEERING ASSOCIATION ... 395
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 396
CONTRACTS AND ORDERS ... 396
CATALOGUES ... 396
LAUNCHES AND TRIAL TRIPS ... 396
MARKETS, NOTES AND NEWS ... 397
CURRENT PRICES FOR METALS AND FUELS ... 398
FRENCH ENGINEERING NOTES ... 399
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 399
FORTHCOMING ENGAGEMENTS ... 400

NOTICES TO READERS.

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AERONAUTICAL RESEARCH.

THE new twenty-four foot wind tunnel at the Royal Aircraft Establishment, South Farnborough, which the Marquess of Londonderry officially opened on Friday of last week, April 5th has been under consideration and construction since 1928. As our readers will gather from the detailed description of it which we are now publishing it is a very noteworthy undertaking from the aeronautical point of view and in its general arrangement and detailed design contains numerous features of wide interest to civil, mechanical, and electrical engineers. We have remarked on a previous occasion that the progress of aeronautical research has been peculiarly fruitful in its influence on engineering as a whole. It has called for the development of new processes of manufacture, new forms of construction, and new materials, and in meeting these demands general engineering and metallurgical practice has benefited itself to an extent the greatness of which is perhaps not generally realised. In addition, in seeking to fulfil its own particular needs and to solve its own particular problems, aeronautics has pointed the way to many fresh developments in diverse technical fields which in some cases are not even remotely connected with the science and practice of artificial flight. In both these respects the new wind tunnel at Farnborough will, it is certain, be found to maintain the inspiring influence which has characterised aeronautical research in the past.

In its construction the tunnel presented many problems in civil, mechanical and electrical engineering, the successful solution of which cannot fail to react beneficially on many branches of practice and on other fields of research. In that connection we might particularly mention the novel problems which had to be faced in the construction of the reinforced concrete structure which constitutes the tunnel proper. Not only was the form required complicated—a tunnel, starting with a bell-mouth, passing from a circular to a rectangular section and, after four right-angled bends, ending in a circular-sectioned contraction—but the accuracy of certain of the dimensions and of the shape at certain points had to be exceptionally high for work of its size. We understand that at the jet end and in the collector the diameters—24ft. in the one case and 30ft. in the other—are correct to within less than one-quarter of an inch. Within the scope of mechanical engineering one of the most interesting problems involved in the construction of the tunnel lay in the design and production of the main balance by means of which the forces acting on full-size machines and components when exposed to the air current are measured. It may be true that the balance is simply an elaborated form of weighbridge—a weighbridge capable of measuring simultaneously the forces applied to it in the vertical and horizontal directions—but it is also true that the specification required the fulfilment of conditions of a nature or of a severity outside the run of normal weighbridge practice. It is a noteworthy fact that the conditions have not only been met, but considerably surpassed and that the construction of the balance was undertaken by a firm hitherto famous for the building of astronomical telescopes and not usually associated with the fabrication of apparatus exercising in any way the functions of a weighing machine. On the electrical side the problems presented were concerned primarily with the control of the power input to the 2000 h.p. motor which drives the 30ft. fan by which the wind in the tunnel is created. It was required that the current of air issuing from the jet orifice of the tunnel should have a considerable range of velocity up to 115 miles an hour, and that at any selected speed the velocity should be held constant to within a very fine figure—about one-quarter of 1 per cent. The arrangement of the controls, credit for which must be divided between a well-known electrical firm and the R.A.E. itself, will be described in a future issue and will be found to present several features and devices of general interest. On the purely aeronautical side the problems which the design of the tunnel presented were naturally of a somewhat specialised nature, but in at least one respect they may have a possible general interest, namely in so far as they involved the devising of means for preventing the accumulation of the exhaust gases from an internal combustion engine in a stream of air continuously circulated past it. In these respects and in others which will be obvious from our detailed description the construction of the tunnel and its equipment will doubtlessly prove to have benefited materially the practice and experience of all those who took part in it. Equally, we may expect, the results of the researches undertaken with the aid of the tunnel will benefit not only aeronautics but the practice of many branches of engineering and allied industries. From the purely aeronautical point of view the tunnel will be devoted very largely to a study of the head resistance of aeroplanes and particularly of the engine and body portion. That there yet remain important opportunities for effecting a reduction of that resistance is very certain. That it is fully worth while expending time and money on their discovery is shown by the fact that according to an official estimate the reduction of the resistance of aircraft by only one-tenth of its present amount would result in a saving of £40,000 in the annual fuel bill of the Royal Air Force. Of the benefits which the researches to be undertaken in the tunnel will confer on general engineering practice one of the earliest will probably be found in the work to be done with a view to increasing our knowledge concerning the cooling of internal combustion engines and its close physical relationship with their wind resistance. With the advent of the compression ignition aero-engine these studies contain increased promise of yielding results which will be directly applicable outside the pure aeronautical field. The water or liquid cooled internal combustion engine will also derive direct benefit from the work to be done at the tunnel on radiator, systems while problems connected with the reduction of engine noise will also, it is probable, be elucidated.

In studying the design and construction of the tunnel and the objects which it is intended primarily to serve we may perhaps be inclined to feel a shade of regret that it has been called into being as a means of increasing the military value of aircraft, ultimately, that is, of augmenting the destructiveness, as a weapon, of one of the most ingenious of man's achievements. To what great ends, the idealist may say, might not all the skill, learning and scientific brilliance here displayed be applied for the advancement of mankind along the paths of peace and prosperity? Some tinge of sorrow he may well feel but he may console himself with the thought of the indirect and consequential benefits which the construction and operation of the tunnel has brought and will bring in many non-warlike directions. If that be not sufficient consolation full relief from depression may be found in the certainty that the ultimate result of scientific research and progress can never be foreseen. It may well be—some shrewd students of warfare already believe it—that the development of the military aeroplane may provide the most powerful and certain means for the preservation of peace that it is within our ability to command.

Transmission Line Insulators.

SINCE transmission lines began to become conspicuous in this country they have been found to be liable to ailments. In industrial areas and in the vicinity of the sea, deposits of dirt or salt often have an undesirable effect upon the performance of insulators. Cleaning may remove or alleviate the trouble, but if it has to be carried out frequently it becomes expensive, not to mention the inconvenience that may be involved. Apart from the undesirability of insulators flashing-over at normal voltage, relatively small leakage currents at a large number of points are anything but beneficial. The practice of over-insulating lines or of cleaning insulators several times a year can scarcely be regarded as satisfactory. During an I.E.E. discussion in 1931 it was stated that there was a line in Scotland on which the insulators had to be cleaned every six weeks. In all probability this is no longer true, for it is difficult to conceive, in the light of existing knowledge, that steps have not been taken to minimise the trouble. Existing insulator designs show improved performance under adverse conditions, although it appears that development work in this direction is still a long way from complete. That it is no exaggeration to say that dirt and salt-laden insulators may prove a very real source of worry to transmission engineers, is evident from the published accounts of the electricity supply failures for which they have been responsible. The greatly increased use of overhead transmission in Great Britain has naturally led to an intensified study of the subject, and to more general consideration of the methods of grappling with defects. Troubles that can be produced by salt deposits were described in a paper on "Some Surge Investigations on Overhead Lines and Cable Systems," presented by Messrs. S. W. Melsom, A. N. Arman, and W. Bibby at an I.E.E. meeting in 1930, whilst dirt deposit troubles were considered by Mr. P. J. Ryle in his paper on "Two Transmission Line Problems: Suspension Insulators for Industrial Areas in Great Britain; Conductor Vibration," read before the same Institution in 1931. A third I.E.E. paper on "Transmission Line Insulators under Deposit Condition," was read by Messrs. W. J. John and F. M. Sayers on Wednesday, March 20th.

In a highly industrialised country such as this, dirt deposits are difficult to avoid, and it is not surprising that in certain quarters the operation of overhead lines has left something to be desired. As a study of American and other technical publications will show, efforts to avoid the flashing-over of insulators under unfavourable atmospheric conditions have been made in many parts. In some cases the maintenance of a reasonable continuity of supply has been far from easy, but in countries in which lines are often put out of action by lightning, in addition to other influences, failures are not always viewed in such a serious light as they are here. On account of the excellent continuity of supply, the British consumer has hitherto experienced, and still expects, the reliability of our transmission systems must be raised to the highest possible standard. Papers such as those to which we have alluded are therefore welcome. To the descriptions of lines that have given trouble in consequence of the deposit of dirt on insulators, Messrs. John and Sayers have added two more. One of the lines is in Kent and the other in Essex, but it must suffice to deal mainly with the former, which is subjected to a considerable amount of pollution along its 6¼-mile route, accentuated in places by cement works. It was put into service in April, 1927. From that date to April, 1929, there were eight faults, due to or followed by the failure of fourteen separate insulator strings, and representing 0·6 failures per month, or about 0·1 failure per mile per month. Usually the faults occurred during mist, either at nightfall or in the early morning. Dead birds were found at certain points at which the faults occurred, but on almost every occasion insulators failed at some other point. By causing one conductor to be earthed, the birds are supposed to have initiated the trouble by causing the voltage on the other conductors to rise and to make certain insulator strings having industrial deposits flash-over. As it was evident that the line was working with a small factor of safety, it was decided to increase the insulation. An additional unit was therefore added to all

two unit suspension insulator strings and rubber bird guards were fitted round the conductor at each insulator position. But during the following twenty-nine months eight faults, involving the failure of nineteen insulator strings, occurred, representing 0·65 faults per mile, or about 0·11 fault per month per mile, which was an increase over the original figure. This unexpected result was eventually accounted for by the fact that the bird guards abounded with insect life. Birds were therefore attracted to them and the faults were increased. Removal of the guards, however, resulted in only four faults occurring in twenty-eight months. Both in Kent and Essex, where an additional unit was also added to the line to overcome the deposit troubles, no faults occurred during or soon after rainfall and no faults were experienced on tension insulators. That is in conformity with experience gained elsewhere. By increasing the original insulation of the Essex line from three to four units almost complete reliability has been attained by carrying out one cleaning operation per year.

But although details are given in the paper of insulators specially developed for service in places in which ordinary insulators are liable to fail, these improved results were obtained by the addition of units of normal design as no improved insulators appeared to be manufactured with the desired characteristics. Insulators have been devised to utilise the good effects of wind and rain, whilst avoiding their bad influences. They are distinguished by having considerable lengths of "washable" outer surfaces and deeply recessed under surfaces intended to delay the formation of a continuous film of deposit which would become conducting when damped. The results of experience indicate, however, that they have not wholly overcome the troubles, although, according to the Central Electricity Board's last report, special insulators put into service on grid lines last summer, completely eliminated flash-overs during the fogs of the succeeding winter. New designs of anti-fouling insulators described by Messrs. John and Sayers are largely the result of the experiences gained on the Kent and Essex lines, but with one exception none of them have been used under practical conditions. They indicate, however, some possible lines of attack upon the deposit problem, which is one of no small importance. Since it has been stated that, after making allowance for all charges, the cost of cleaning the insulators on a mile of single circuit line on the North-East Coast is between £9 and £10, it is evident that research work in this connection may easily prove profitable. That it should be necessary to employ different types of insulators to meet different conditions, such as "ordinary," "severe," and "extreme" salt conditions, is unfortunate. Speaking during the discussion, Mr. W. Fennell contended that one type of insulator should be produced to meet all conditions. Once put into service, it should never require cleaning or attention of any kind. That such an insulator would be appreciated we do not doubt, but, apart from design and constructional difficulties, its cost would in all probability be an obstacle to its use on lines that do not come within the scope of Messrs. John and Sayers' paper.

Institution of Naval Architects.

No. I.

THE Spring Meetings of the Institution of Naval Architects opened in the Lecture Theatre of the Royal Society of Arts, 18, John-street, Adelphi, London, W.C.2, on Wednesday morning, April 10th, the chair being taken by the President, the Right Hon. Lord Stonehaven. The attendance was larger than last year, and reflected the improved outlook in the shipbuilding and marine engineering industry which is being maintained.

Annual Report and Accounts.

The Secretary, Mr. R. W. Dana, presented the annual report of the Council for 1934. In it it is stated that although the losses from death and resignation exceed the gains from new candidates elected, yet the reduction in membership is less than at the close of the preceding year. The Council trusts that this improvement may be maintained. The total number on the roll of membership is now 2553, compared with 2567 in 1934 and 2649 for the preceding year. The account and financial statement was presented by Sir Charles Sanders, the hon. treasurer. They show a satisfactory financial position.

Trewent and Wakeham Legacies.—A legacy of £4000 under the will of the late Mr. Francis J. Trewent, M.I.N.A., has been handed over to the Institution, and in accordance with the testator's directions has been devoted to establishing a "Trewent" Scholarship in Naval Architecture, which will be offered for competition this year for the first time. In addition to this bequest, Mr. Trewent left two interesting pictures of sailing frigates by Thomas Sommerscales, which now hang in the Council Room of the Institution.

A bequest of £500 has been made to the Institution under the will of the late Mr. J. F. Wakeham, M.I.N.A., who desired that it should be used at the discretion of the President for the benefit of the Institution or of any charity connected therewith. The Council, at the request of the President, propose to allocate £300 to the Institution Benevolent Fund, and with the remainder establish a prize bearing the name of the donor.

Honorary Vice-Presidents.—The Council has elected as Honorary Vice-Presidents Mr. J. Foster King and Sir Eustace H. T. d'Eyncourt, Bart., in recognition of their long and valuable services on the Council.

Members of Council.—The result of the ballot for the election of Members of Council was as follows:—Vice-Presidents:—Mr. G. S. Baker, Mr. M. E. Denny. Members of Council:—Mr. A. L. Ayre, Eng. Vice-Admiral Sir Harold A. Brown, Eng. Capt. W. J. Willett Bruce, Mr. J. Callander, Mr. A. J. Campbell, Mr. J. Denham Christie, Eng. Commander C. J. Hawkes, Mr. John Johnson, Mr. M. P. Payne. Associate Members of Council:—Mr. T. W. Revans, Mr. A. M. Robb, Sir Philip H. Devitt, Mr. W. L. Hichens, Sir George Higgins.

William Froude Laboratory.—The work at the William Froude Laboratory continues to increase year by year, and the research carried out there has yielded valuable results. The Lithgow Tunnel is now complete, and is being carefully calibrated before being put into service. Owing to the large amount of private work, as well as research, it has been necessary to increase the staff at the Tank, but even so a considerable amount of overtime has had to be done. The Council earnestly appeals for liberal contributions from shipbuilding and engineering firms.

Secretary's Resignation.—The Council received with the greatest regret an intimation from Mr. R. W. Dana that, having attained the age limit for retirement, he felt bound to tender his resignation. At the request of the Council, Mr Dana consented to retain his office until after the Spring Meeting, and it was decided to appoint an assistant to the Secretary with a view to his promotion to the post of Secretary at an early date. Lieut.-Commander Edgar P. Young, R.N. (ret.), was selected for this post. The Council desires to place on record its sincere appreciation of the invaluable services rendered by Mr. Dana to the Institution during the thirty-four years that he has held the office of Secretary. His informed mind and sympathetic temperament, combined with administrative ability of no mean order and an ardent devotion to the interests of the Institution, have been distinguishing features of those services, retaining the constant admiration and esteem of his colleagues and associates. He carries into his retirement the lasting gratitude of both the British and foreign members of the Institution, and their sincere wishes that he may long be spared to enjoy a well-earned leisure.

Gold Medal and Premium.—The Gold Medal for the past year was awarded to Vice-Admiral Y. Hiraga, I.J.N. (ret.), Tokyo University, for his paper "Experimental Investigations on the Resistance of Long Planks and Ships"; and the Premium to Professor B. P. Haigh, of the Royal Naval College, Greenwich, for his paper "Further Tests and Result of Experiments on Electrically Welded Joints in Ship Construction."

National Certificates in Naval Architecture.—Awards of National Certificates in Naval Architecture were made as follows:—England and Wales, six Higher and four Ordinary; Scotland, three Higher and eight Ordinary. The Duke of Northumberland Prize was awarded to Mr. William P. Walker, of the Royal Technical College, Glasgow.

After the completion of the ordinary routine business, Lord Stonehaven read the following address.

The President's Address.

The annual report which you have just heard would appear to reflect the more hopeful outlook which now lies before the shipbuilding industry, with which we are so intimately concerned, an industry which may well be termed the "key" industry of these islands. Small though the output of our shipyards has been during 1934—the third smallest, indeed, which has been recorded since the first issue, in 1888, of Lloyd's Register—it represents, nevertheless, an improvement on that of the previous year, an improvement, moreover, which seems likely to be maintained.

So far as the Institution is concerned, we are in the fortunate position of having, during the past twenty-five or thirty years, followed a conservative policy with regard to our finances, and successive treasurers have, with the Council's approval, built up a reserve fund which has enabled the Institution to acquire a valuable freehold in the heart of London on that delightful estate which has since its inception been the official, as well as the "spiritual," home of the Institution. Further, it has enabled us to set aside a staff superannuation fund, which is now very nearly sufficient to meet all probable requirements to assure adequate retiring allowances to those who have loyally served the Institution in the past and for their successors in the future. We can therefore look hopefully to being able to carry on our active work of developing the scientific side of naval architecture without that feeling of apprehension which so often hampers the activities of scientific societies whose resources are inadequate to their constructive programmes. But we must not on that account be lulled into apathy, and we are dependent not only on the continued interest taken in our work by our present members, but we need, year by year, to see our roll of membership increased in numbers, and raised in quality by the inclusion of as many of the leaders as possible in the shipbuilding and engineering industries. And not only those, but naval officers, shipowners, and others whose interest in the advancement of naval architecture is hardly less direct than that of the designers and constructors themselves. Ours is an open door, and we gladly welcome all members and visitors alike, to contribute to our "Transactions" and take part in our discussions. The hard times through which shipbuilding has been passing have naturally taken toll of our members, as so many have fallen on evil days, and have had to fall our of the ranks, but I would remind you that ours is one of the very few engineering institutions that has not required to increase its rate of subscription since pre-war times, and still gives the same service to its members as before.

It is therefore up to you gentlemen, to do what you can to encourage all who are eligible, and especially the younger men of the profession, to join up and help us to maintain the prestige of the Institution.

The shipbuilding event of the year has, of course, been the launch of the "Queen Mary," which you will hear described shortly in a very interesting paper by one of our members. The completion of this magnificent vessel will mark the return, and we hope the successful return, of this country into the contest for the much-coveted "blue ribband" of the Atlantic. Other interesting items in our programme of mercantile shipbuilding have been the eight "Empire Food Ships," built for carrying refrigerated cargoes to this country from Australia and New Zealand, and the three train ferries, built for service in the English Channel. Both of these types of shipping will be dealt with in papers during this meeting. The comparatively small number of the tankers which have been built is to be regretted, but, in view of the short life of these ships and of the increased demand for oil which will result from the slowly dawning improvement of world trade, it has been calculated that some 750,000 tons of tanker tonnage will be required to be built each year during the next five years. Our shipyards may therefore, it seems, expect considerably increased orders for this type of vessel in the near future.

It is no exaggeration, however, to say that there can be little hope for shipbuilding unless shipping is in a healthy financial condition, and it is with relief therefore that we welcome the subsidy granted by the Government to tramp shipping. In granting this subsidy the Government has shown that it is determined that this country shall preserve its place in the sea-going trade of the world in the face of competition by subsidised foreign rivals.

It has caused no little disappointment, though, in shipbuilding circles to note that a hostile reception has been accorded by some shipowners to the proposed advances of up to £10,000,000 for building new ships or modernising existing ones; advances which have been described as "devised in the interests rather of shipbuilders than of shipowners." It is obvious, of course, that it would be to the interest of shipbuilders if full advantage were taken of the facilities now offered by the Government, but surely it could be argued that it would be to the interest likewise of shipowners. The experience of recent years would appear to indicate that in the future success in shipping will depend, not on subsidies (which cannot be continued indefinitely), but on the good management of ships of the highest efficiency.

It may be claimed that a large proportion of our mercantile fleet (a larger proportion perhaps than that of some of our rivals) is still by no means ready for scrapping. But is that the only right criterion whereby the shipowner may decide when to replace his ships by new ones? I wonder whether he applies the same criterion to his motor car—the thought of what would be the plight of the motor manufacturers if it were generally applied to their products rather makes one shudder.

Research in naval architecture and in marine engineering has placed at the disposal of the shipbuilder a vast amount of accurate information, which, properly applied, makes it possible for him to construct ships of a greatly increased all-round efficiency.

What is more, these ships can, under existing conditions, be produced at relatively low cost. I would therefore earnestly recommend to the shipowners of this country, whether they avail themselves of the assistance offered by the Government or utilise their own financial resources, that they seriously consider the immediate adoption of a policy of "scrap and build," bearing in mind not only the welcome assistance it would afford to a sister industry in distress, but also the moral effect on those serving in their fleets, of feeling that their ships were technically the most efficient and were the most comfortable in the world. While I am on this subject, I might recall to the minds of all who are concerned with ships and shipping, whether they be marine engineers, shipbuilders, or shipowners, or if they serve at sea, the deep debt of gratitude which they owe to the research workers of the past and of the present for their hard work and selfless enthusiasm, which has made possible the progress to which I have referred. I feel certain that I have the support of this meeting in expressing the thanks of our Institution to that body of workers, to many of us nameless, who have done and do so much to further the progress of naval science. It is invidious on such occasion as this to single out any individual or group of individuals for special thanks, but I may be excused perhaps if I do so in the case of the staff of the William Froude Laboratory, who, under the able and enthusiastic direction of Mr. G. S. Baker (Vice-President of this Institution), successfully carry on work which is of such vital importance to naval architecture.

May I venture to appeal once again for liberal support to the Research Fund of the William Froude Laboratory, which has to face expanding requirements on inadequate resources?

The announcement of the Naval Estimates for the coming year and the prospects of an enlarged programme of naval construction foreshadowed in the Prime Minister's Statement Relating to Defence have shed yet another ray of hope on the shipbuilding industry. At a time when our yards are still denuded of orders for mercantile ships, when only one-third of our reduced total number of slips are occupied, and when over 46 per cent. of our shrunken number of technicians are still in enforced idleness, it will be a welcome relief to have some more warships to build. The heavy burden of taxation upon our sadly depleted national income is already such, however, that it would be folly to embark lightly upon a new competition in naval armaments, but, on the other hand, we must bear always in mind how vital to the health, nay even to the existence of our commonwealth, are the lines of sea communication which link it to the Mother Country, and to the rest of the world. In spite of our efforts to obtain disarmament by example, and by agreement, the lead given by this country has failed to evoke adequate response; while we have consistently decreased our expenditure on armaments, the world expenditure on armaments has increased, with the result that to-day our national and Imperial security is in jeopardy. We welcome, therefore, the Government's action in making it quite certain that no misunderstanding should exist either at home or abroad as to this nation's intention, until such time as a satisfactory system of collective security has been established, of maintaining its naval defences at such a standard as will ensure confidence in its ability to uphold British prestige in the eyes of the world, and to safeguard her commercial interest and vital lines of communication in every quarter of the globe.

Navies, however, cannot be created or expanded in a year. The ships and the costly plant required for their construction cannot indefinitely be maintained in idleness, but always ready for instant use, nor can an adequate army of highly skilled technicians be recruited, trained, and suitably employed until the day the nation needs them. While therefore we earnestly hope that the Government will succeed in arriving at a satisfactory international agreement to replace those of Washington and London, when they expire next year, we hope also that, subject to such agreement, they will steadily persevere with a planned programme of construction which will provide for the regular replacement of obsolete ships year by year. If this were done the shipbuilding industry would be able to make its plans accordingly, and the prospects for employment in that industry would again be sufficient to attract the most promising of our young shipbuilders and engineers, on whose services its success is ultimately based.

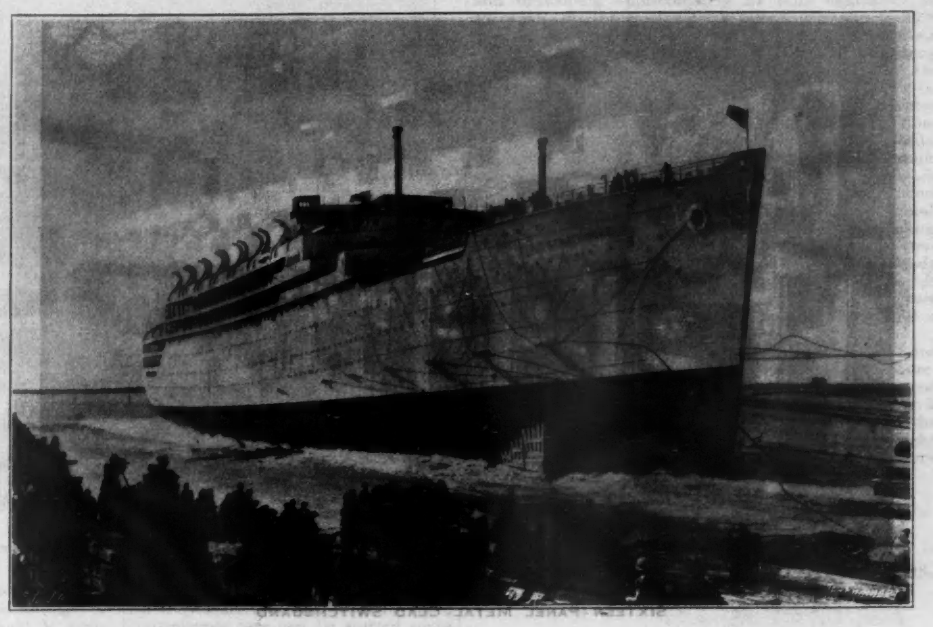
(To be continued.)

The New P. & O. Liner *Strathmore*.

ONE of the year's noteworthy ships is the twin-screw turbine-driven passenger liner "Strathmore," which is being constructed by Vickers-Armstrongs, Ltd., at Barrow-in-Furness, for the P. and O. Company's express service between the United Kingdom and Bombay. This fine ship was safely launched on Thursday last, April 4th, the naming ceremony being appropriately performed by Her Royal Highness the Duchess of York. The liner will, it is expected, enter her owners' service in the early autumn of the present year. The "Strathmore" is the largest ship laid down for the Peninsular and Oriental Steam Navigation Company, and she will be the largest and fastest vessel yet built for the Europe-India service.

HULL DESIGN.

In the table given below we reproduce the principal hull dimensions and give some particulars of the passenger accommodation provided, and the propelling machinery. The ship has eight decks, alphabetically designated "A" to "H," including the promenade decks, all of which are intended for the use of passengers. The hull is subdivided into twelve transverse water-tight compartments up to the level of "F" deck. It has a continuous double bottom from the collision bulkhead to the after end of the shaft tunnels, and is divided transversely and longitudinally to provide a large number of tanks for fresh water, boiler feed water, water ballast, and oil fuel.



LAUNCH OF THE P. & O. LINER "STRATHMORE"

Hull Particulars.

Length between perpendiculars	630ft.
Length overall	665ft.
Breadth moulded	82ft.
Breadth overall	84ft.
Depth moulded to "F" deck	38ft.
Depth moulded to "E" deck	47ft. 6in.
Gross tonnage	24,000
Designed service speed	About 22 knots

Passenger Accommodation.

First-class passengers	445
Tourist class passengers	665
Officers and crew	510

Propelling Machinery.

Type: Parsons twin-screw single-reduction geared turbines	
Designed output	24,000 s.h.p.
Astern power	Approx. 16,800 s.h.p.
Turbine speed	1715 r.p.m.
Propeller speed	112 r.p.m.
Type of condenser	Weir regenerative
Total surface	25,000 sq. ft.
Working vacuum: 28in. at 30in. bar. and 86 deg. Fah. sea temperature	
Type of boiler: Oil-fired Babcock and Wilcox water-tube	
Number of large boilers	Four
Number of small boilers	Two
Working pressure	440 lb./sq. in.
Total superheated steam temperature	725 deg. Fah.

Auxiliary Power and Lighting Sets.

Three B.T.H. 500 to 550-kW, 220-volt turbo-generators

Further, the vessel, from the forward cross oil fuel bunker to the after end of the engine-room, is protected by a complete double skin up to the water line, thus providing a maximum margin for safety at sea.

SOME SAFETY PRECAUTIONS.

A full complement of lifeboats, including two motor boats, equipped with patented "skate" launching gear, and davits of the latest type, is carried on "A" deck. The boats are designed to accommodate the whole ship's company should necessity arise, and to provide the usual service of craft for the conveyance of passengers between the ship and the shore when she goes on cruises.

For the safety of the vessel in case of fire the Lux-Rich system of smoke detection and alarm has been adopted, together with a complete installation of Mather and Platt sprinklers, arranged so that a fire in any part of the vessel so protected shall be subdued automatically. For additional safety the whole of the woodwork in the passenger accommodation and crew's quarters is covered with fire-resisting paint, while fireproof doors are fitted in all the main alleyways. Air conditioning plant has been installed in the first-class dining saloon. Besides this, the Thermotank mechanical system of ventilation is to be fitted in all public rooms and in the accommodation of both passengers and crew.

CARGO ARRANGEMENTS.

Insulated cargo will be carried in Nos. 1, 2, and 3 holds and in the 'tween decks forward, and Nos. 4, 5, 6 lower holds aft will be used for the stowage of general cargo, with provision for the carrying of passengers' motor cars. The cargo will be worked by means of derricks served by 3-ton and 5-ton winches distributed throughout the vessel, while in addition four 10-ton derricks are provided. The arrangements are of the latest and most efficient type for the rapid handling of cargo.

PROPELLING MACHINERY.

The vessel is to be propelled by twin screws, driven by two sets of Parsons turbines, through single-reduction gearing, each set comprising one high-pressure, one intermediate-pressure, and one low-pressure turbine, working in series and driving separate pinions engaging with the main gear wheel. We saw the machinery in course of construction in the works.

The high-pressure turbine is of the impulse reaction type, the first stage consisting of an impulse wheel with two rows of blades, and the remainder of this turbine comprises six stages of reaction blading mounted on a hollow drum of forged steel. The intermediate-pressure turbine is of the reaction type, having seven stages of blades mounted on a hollow forged steel drum; while the low-pressure turbine is of the single-flow type, with sixteen rows of reaction blading mounted on forged steel disc wheels. The astern turbines consist of one high-pressure and one low-pressure turbine, working in series, the H.P. astern turbine comprising one impulse three-row wheel, being incorporated in the intermediate cylinder. The low-pressure astern turbine is incorporated in the L.P. casing and consists of one two-stage impulse wheel, followed by five stages of reaction blading. We noted that the rotor shafts of all the turbines are packed with both labyrinth and carbon packing, and that "Michell" type pivoted adjusting blocks are fitted to the turbines.

The turbines are connected by flexible couplings to nickel steel pinions, which engage with the main wheels on the propeller shafts. Double helical single-reduction gearing with Vickers-Bostock-Bramley patented "enveloping" gear teeth is used, the gear wheels consisting of cast iron centres with forged steel rims shrunk on and securely fastened to the gear wheel shaft. Central bearings are not fitted to the pinion shafts. The shaft bearings for both the turbines and the gearing are supplied with forced lubrication, and the thrust blocks, which are of "Michell" type, are placed on the shafts close up to the gearing. Propellers of the built-up type are employed, each having four blades of manganese bronze, which are secured to the cast steel bosses by mild steel studs and gun-metal cap nuts. A cast iron cone is fitted over the propeller nut. Electrically operated turning gear is provided for the turbines and shafting.

BOILERS.

The steam generating installation consists of Babcock and Wilcox high-pressure type boilers, four large and two small, fitted with superheaters and tubular air heaters. The working pressure at the boilers is 440 lb. per square inch, superheated to 725 deg. Fah. The total generating surface of the four large boilers is 29,860 square feet with a total superheating surface of 7440 square feet, the total generating surface of the two small boilers being 7170 square feet, with a total superheater surface of 2140 square feet, while the air heating surfaces for the large and small boilers are 32,000 square feet and 8000 square feet respectively.

All the boilers are arranged to burn oil only, under the forced draught closed air duct system with open stokeholds. Air is supplied to the boilers by five Howden double inlet electrically driven fans.

THE LAUNCH LUNCHEON.

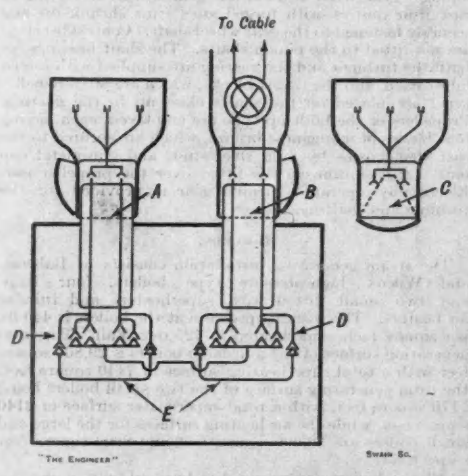
After the launch of the ship the Royal party visited the gun mounting shops and the engine works, and also inspected the cruiser "Ajax," which was completed last week and has just been handed over to the Admiralty. At the luncheon the toast of "Success to the 'Strathmore'" was given by General the Hon. Sir Herbert H. Lawrence, the chairman of Vickers Ltd. The Hon. Alexander N. Shaw, the chairman of the P. and O. Company also spoke and presented to the Duchess of York a copy of her portrait painted by Mr. Simon Elwes. The original painting will hang in the completed "Strathmore." The Duke of York replied to the toast and proposed the "Future Prosperity of the Firm of Vickers-Armstrongs, Ltd.," coupled with the names of Sir Charles and Lady Craven. In his reply, Sir Charles Craven referred to the happy relations which existed between Captain W. H. Sweny, the marine superintendent of the P. and O. Company; Mr. R. W. Rugg, the company's naval architect; and Mr. R. T. Clarke, the senior superintendent engineer of the company; and the senior members of Vickers-Armstrongs' Barrow staff.

Metal-clad Switchgear.

The sixteen-panel metal-clad switchboard shown in the accompanying illustration has been supplied by the General Electric Company, Ltd., to the Norwich electricity supply undertaking. It has been installed in the Duke-street sub-station for the control of a 6000-volt, three-phase, 50-cycle supply, its breaking capacity being 350,000 kVA. It is provided with duplicate bus-bars, which are selected in accordance with the transfer circuit breaker system. Of the sixteen units, six control the supply to rotary converters, while the remaining ten serve as feeder control units. With the exception of two solenoid-operated units, each switch comprises a manually operated circuit breaker, with its associated bus-bar sections, current and potential transformer protective relays and instruments mounted on a framework between two pedestals.

SIXTEEN-PANEL METAL-CLAD SWITCHBOARD

The vertical isolation principle adopted affords a saving in space from back to front of approximately 20 per cent., as compared with that of the horizontal system of isolation necessitating the use of racks. Measured from the wall, and allowing a 3ft. gangway, the actual dimensions are 56ft. long, 9ft. 1in. high, and 9ft. 4in. wide. The bus-bar chambers are all composed of cast silicon-aluminium, which has the advantages of being non-magnetic and non-burning, and of reducing the weight by an appreciable amount. The weight has also been reduced by making the upper portions of the circuit breaker stems form the isolating plugs, and avoiding the use of compound-filled hoods. This also reduces the number of insulators required.



FIXED AND MOVING CONTACTS ON CIRCUIT BREAKER

The method of mounting the current and potential transformers so that no part of the equipment has to be removed in order to gain access to them facilitates accessibility and ease of maintenance, and it is possible to erect this type of board with a minimum clearance between the back of the gear and wall of only 6in. The manually operated circuit breakers are actuated by a long steel rod in front of each unit. The trip mechanism is of the free-handle type, and the operating mechanism is mounted on the circuit breaker top plate. Strong accelerating springs give the correct speed of operation when the breaker opens. All the breaker contacts conform with G.E.C. standard practice, and the usual mechanical protective features are included, such as the provision of automatic shutters to cover the fixed sockets when the breaker is lowered.

For the isolation of the circuit breaker a motor-operated hydraulic hoist is inserted under the breaker. Means are provided to ensure registration of the breaker to obtain correct alignment with the fixed isolator contacts. As each breaker can be supported on the framework in the isolated position, the tank can be lowered independently to expose the contacts for inspection. By means of a separate transport truck the complete breaker can be lowered and removed from the switch-board for overhaul.

When changing over a breaker from one set of bus-bars to the other, it is first isolated by means of the electrically operated hoist. In the isolated position the wheels, which are fitted to the top plate, rest on rails on the main framework, and the breaker can therefore readily be moved into its alternative position and be plugged into the second set of bus-bars, which are of tubular section and arranged in trefoil fashion. They are supported in their housings by laminated bakelite plates with bushes of the same material fixed into the ends of each section of the chamber. Tubular bus-bars in trefoil formation have been employed to avoid the high losses associated with solid or parallel laminated bus-bars. The tubular type gives the most uniform current distribution in individual bars, and therefore the minimum loss arising from self-induction, while the trefoil disposition gives the minimum loss due to mutual induction. With the tubular arrangement, moreover, those portions of the bars at highest density have in the continuous wall of the tube an excellent path for the flow of heat towards the outside. The shape of the bus-bar chambers follows as closely as possible the contour of the bars, a construction that offers the advantage that a partial earth barrier is provided between the phases. A maximum cooling surface is also obtained, and the thickness of the compound through which the heat has to travel is reduced to a minimum. Current transformers are housed in the fixed portion of the switch-gear between the circuit breaker and cable box, the transformer chambers being filled with "Penetrol" after the board was erected on site.

The potential transformers are housed in rolled steel tanks filled with oil, and are isolated vertically by the hoist that is used for the circuit breakers. High-voltage fuses and current-limiting resistances are provided to isolate faulty primary windings from the bus-bars. The protective gear includes the usual overload and earth-leakage relays. The breakers are tripped by relays and are therefore equipped with shunt trip coils, the tripping circuit being energised from a 220-volt D.C. supply.

In the case of two of the feeder units, split conductor protection is provided, which necessitates a special system of fixed and moving contacts on the circuit breaker. This system, which is said to be the only one of its kind for use on metal-clad switchgear employing a transfer breaker, is covered by patent No. 406,775, and is illustrated in the diagram.

One of the bus-bar plugging spouts is behind the cable plugging spout, and the other in front of it. There are thus only three plugging spouts per phase, A, B, and C, the centre spout B being used for both breaker positions. Either terminal of the breaker may be connected with the cable. With split conductor protection it is necessary to carry the splitting or separation of the two parallel conductors right up to the break contact, so that when the breaker opens, the two parallel conductors or splits are electrically isolated from one another. Moreover, to secure a high degree of sensitivity of operation, it is necessary when closing the breaker to energise both splits at precisely the same instant. In a circuit breaker in which the same terminal is always connected to the cable, such as on a single bus-bar system, it is customary to energise both splits by providing one terminal of the breaker with longer contacts than those on the terminal connected to the bus-bar. Thus, when the breaker is being closed contact is established earlier on the cable side than on the bus-bar side, so that the splits are parallel before being energised.

In switchgear of the transfer breaker type, however, both terminals of the breaker must be arranged for connection to the cable, so that the splits can be parallel before energisation. This is done by carrying the conductor splitting down each terminal to the point of break, while, in addition to the normal break contacts, two extra contacts D are fitted on each terminal. On each moving contact an insulated bridging contact E is mounted to engage the contacts just mentioned. The bridging contacts are longer than the normal circuit contacts, so that each pair of splits is definitely parallel before the circuit is completed between the terminals. The presence of the extra contacts D, and the bridging contact on the terminal which is connected to the bus-bar, does not affect the principle of the system, as the splits on that terminal are parallel at the bus-bar plugging socket whenever the breaker is in the service position.

Another point of interest is the arrangement of the totally enclosed instrument panels, which are self-contained and hang on the front of the pedestals of each unit. Apart from the accessibility of the instruments themselves, it is a simple matter to gain access to the oil circuit breakers by swinging the panel on its hinges.

A New Oil Purification Process.

On Wednesday, April 3rd, after an excellent luncheon at the Dorchester Hotel, under the chairmanship of Mr. Wilson Cross, chairman of the Vacuum Oil Company, Ltd., Mr. O. T. Jones, chief engineer to the company, gave a short lantern lecture on "The Clearosol Solvent Extraction Process for the Purification of Lubricating Oils." This process has already been brought to an industrial scale in America, where three complete plants, each with an output of 3000 barrels per day, are in operation.

Despite the progress that has been made in the distillation and purification of lubricating oils, it has hitherto remained impossible to remove, commercially, certain low-grade constituents. These constituents are found even in the oils refined from the best crudes, and since they consist of unstable hydrocarbons, some of a tarry nature, they cause carbon deposits in motor cylinders, sludge in crank cases, sticky deposits in various parts of the mechanism, and general ills with which the motorist is only too familiar.

The object of the research which has led to the successful development of the new process was to remove these undesirable constituents without diminishing in any way the lubricating properties of the oil. This object has been achieved by the perfection of a process which, as Mr. O. T.

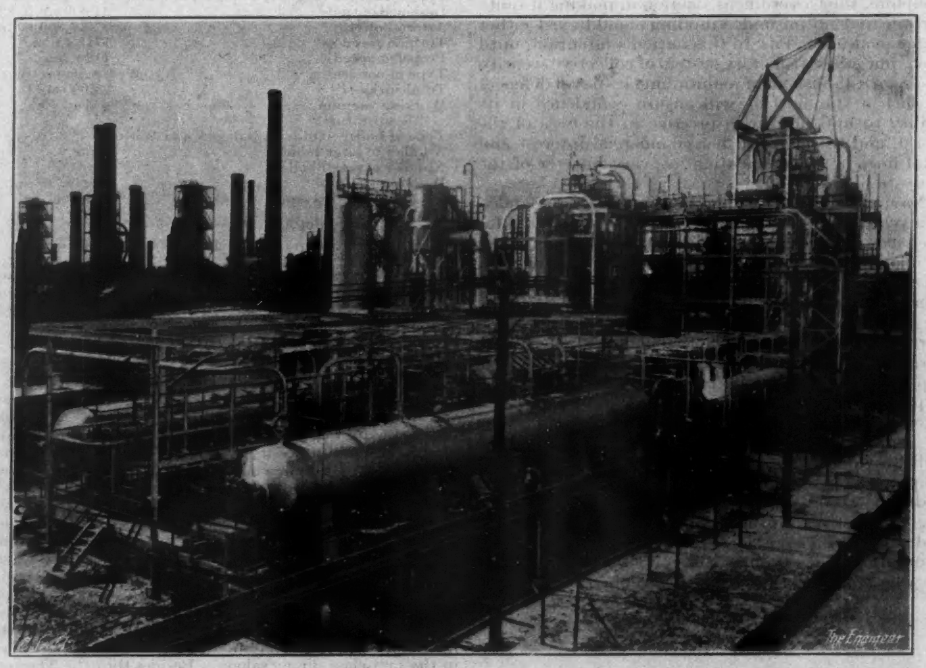


FIG. 1—GENERAL VIEW OF OIL PURIFICATION PLANT IN PAULSBORO, PENNSYLVANIA

Jones said, is rather physical than chemical. It removes entirely the conventional treatment with sulphuric acid, and even the filtration through clay can be dispensed with, if desired. Broadly speaking, it consists in no more than the mixing of the distilled oil with two solvents simultaneously: propane, which dissolves the paraffinic hydrocarbons, and cresylic acid (liquid carbolic acid), which dissolves the tarry groups. During this process asphalt and asphalt forming substances are precipitated. The two solvents are mutually insoluble, and as they have widely different specific gravities—liquid propane about 0·5 and cresylic acid 1·044—they can be readily separated by gravitation. Propane is a gas at atmospheric pressures and temperatures and the process requires, therefore, that during purification it be kept under a pressure of 250 lb. per square inch at which it is liquid. It picks up the desired paraffin hydrocarbons and is easily removed from them by distillation, leaving the purified oil behind. As Mr. Jones put it, "A partial, but simple, analogy is the separation of a mixture of sugar and sand by washing it in water. The water will dissolve the sugar, leaving the sand behind, and the water can then be evaporated from the sugar, leaving it in a pure state and unaffected by the treatment."

We reproduce in Fig. 4 one of Mr. Jones' diagrams, which shows the complete process. At the top the fractionated and blended oil passes into a tank, where it is mixed intimately with liquid propane from the source on the left, and cresylic acid from the source on the right. The mixture, under a pressure of 250 lb. per square inch, enters the extracting tank, where the heavy cresylic acid with its burden of undesirables settles to the bottom and is led off to a separator, whilst the propane with the burden of desirables, floating above, is carried to an evaporator, which leaves the purified Clearosol stock behind. Mr. Jones exhibited a specimen glass full of the black tarry residual. It is so viscous as to be almost solid at room temperatures. Whether it has any commercial value remains to be seen. It has been given the portmanteau name "Slum," from "sludge" and "gum."

Mr. Jones dwelt upon the qualities of this purified lubricant and showed the results of N.P.L. tests of it. There can be no doubt at all that for motor cars and similar purposes it has considerable advantages. The viscosity curves are flatter than those of the usual motor lubricating oil, with the result that the oil being more liquid at lower temperatures cars can be started more easily from cold and less strain is put upon the starter and therefore upon the battery. Furthermore, there is good indication that cylinder wear at starting will be reduced by the more rapid circulation of the oil. But an even more important characteristic, perhaps, is the almost complete removal of sludge from the sump and other parts of the engine. A couple of slides from photographs of a timing case showed clearly the difference in this respect between untreated and Clearosol treated lubricant. Jakeman tests were carried out at Teddington and showed that in respect of seizure the removal of the tarry constituents effected a marked improvement, whilst a reduction of the coefficient of friction of a quite considerable amount was realised. At the Laboratory a bench test in which the oil sump temperature was maintained at 100 deg. Cent. was run for a period of one hundred hours, with the engine, a typical 12 h.p. four-cylinder model, making 2600 r.p.m., and developing approximately 21 h.p.—equivalent to 42 m.p.h. on the road with a saloon car, and to 4200 miles' running at the stated speeds. In order to maintain this high oil temperature during the test, the sump had to be electrically heated. The objects of the test were to punish the lubricant as much as possible by increasing the oxidation effects by the use of elevated temperatures, and to show whether under these conditions the valves were subsequently free from gummy deposits. Obviously, at these high sump temperatures one would also expect the oil consumption to be relatively high, while the measurements for engine wear, both in the cylinders and bearings, might be expected to increase above normal. Although the test was not run continuously, thus making for more severe wear conditions, the engine wear was negligible, both in cylinders and bearing, and, as already mentioned, there was little or no gummy deposit. It was not necessary to add any oil to the crank case during the whole hundred hours' test, less than half a gallon of oil in all being consumed.

We reproduce herewith three photographs taken at one of the three American plants, that at Paulsboro, Pennsylvania. In the general view, Fig. 1, the solvent recovery equipment is seen in the background. Fig. 2 shows the complete extraction unit, and in Fig. 3 the propane towers are seen in the foreground, on the right the extraction shed, and behind, the solvent recovery equipment.

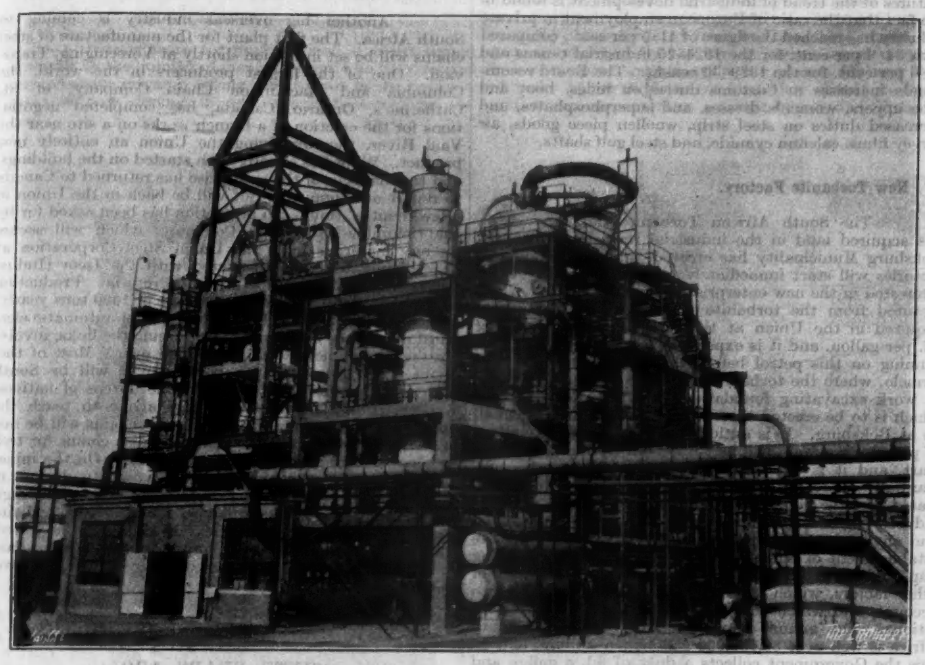


FIG. 2—EXTRACTION UNIT

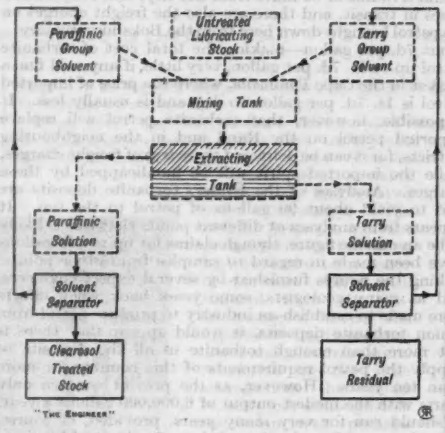


FIG. 4—DIAGRAM OF PROCESS

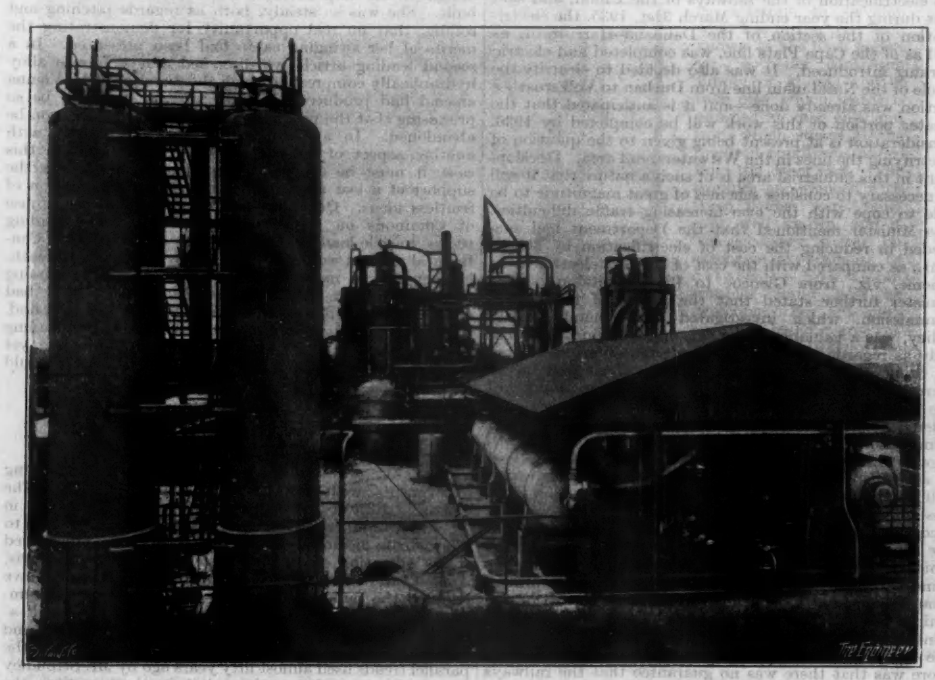


FIG. 3—PROPANE TOWERS AND EXTRACTION SHED

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, February 15th.

Faster Cargo Ships.

DURING the last year or so there has been a big step forward in regard to the speed of vessels trading from different parts of the world to South Africa. But even for the last five or six years Norwegian, Dutch, and German companies, thanks to fast vessels, have gradually taken the cream of the cargo traffic on the Australian and New Zealand routes. This has been particularly the case with the Wilhelmsen motor liners, with speeds of 16 and 17 knots, and in the case of the "Tricolour," which at present holds the Australian Wool Derby record, a speed of a little better than 18 knots. Several British lines had begun to recognise the necessity for more speed, and the entrance into the Europe–South African trade of the five Italian liners subsidised by the Union Government, stimulated others, so that now the Union Castle Company is building two 25,000-ton mail boats that for speed will surpass the two crack Italian boats, one of which can touch 22 knots. Also the company is building two fast intermediate passenger ships, fitted for the fruit trade, which are to be the fastest on the round Africa route, and also two fruit ships to have a service speed of 16 knots. The Clan Line is also putting on 16-knot ships for the S.A. fruit trade, and there has recently visited Cape Town, *en route* to Australia for the wool season, the Shaw, Savill and Albion Line's "Waiwera," said to be the most powerful cargo ship afloat. On her trials this ship did a speed of 18·6 knots. She will be quickly followed by two more vessels of the same speed. Other British lines are placing fast ships on the Europe–S.A. and Europe–Australia–New Zealand routes, and German and Dutch lines are joining the competition, the shipping companies of both countries having ships building and having also had ships running lengthened and fitted with more powerful engines. All this tends to intensive expensive competition, especially as it is not likely that the present level of imports will be maintained after the depleted stocks held in the Union have been replenished.

CAPE TOWN, March 1st.

More Railway Engineers.

The Union of South Africa Railway Administration has decided, as an experiment, to make a drastic change in the method of technical supervision of the Permanent Way and Works Department from now. A new scheme for supervising maintenance staffs on the Eastern Transvaal system, includes places so far apart as Komatipoort, Rustenburg, and Beit Bridge. Engineers who have been stationed at headquarters, Pretoria, will be transferred to various places on the system. Instead of an engineer being responsible for approximately 500 miles of open lines which he has controlled from distant headquarters, he will in future concentrate on a far shorter length of line and supervise it more effectively. Section engineers, as they will be termed, have been allotted considerably greater responsibility. Instead of permanent way inspectors taking charge of the line, the new method ensures that each section will fall under the direct responsibility of a qualified engineer. The engineer will be in charge of an office staff recruited from the reorganised inspectors' offices throughout the system. The engineer will conduct all the work of investigation, attend to public inquiries, and undertake important duties connected with the track, such as levelling, planning alterations, improvements, and so on. Increased efficiency is confidently anticipated as a result of the changes. Avenues for employment of qualified university youths will be increased as it will not be possible effectively to bring into operation the changes without increasing the engineering staff. This, in turn, will involve an increase in the number of

pupil engineers, and greater scope will be given to pupils in the Administration's Engineering Department.

Table Bay Trade Improvement.

The great recovery in trade conditions in South Africa during 1934 is clearly shown in the statement of cargo landed, shipped, and trans-shipped at Table Bay Harbour (Cape Town's port) during that year. The total amount of cargo handled during 1934 was 1,545,284 tons, against 1,309,105 tons in 1933, an increase of 236,179 tons. Imports increased from 854,462 tons to 1,042,128 tons, and exports from 362,883 tons in 1933 to 399,245 tons in 1934. Trans-shipment figures were 10,832 tons, against 10,942. Among the imports, general cargo showed the biggest improvement, rising from 708,041 tons to 891,387 tons. Bulk petrol increased from 73,314 tons to 83,796 tons, and bulk paraffin from 19,631 tons in 1933 to 26,732 tons in 1934. Oil fuel landed showed a big drop from 53,476 tons to 40,313 tons. A good maize season was responsible for the increase in exports. Maize exported during 1934 amounted to 121,260 tons, against 86,474 tons in the previous year. General cargo was steady at 241,596 tons, against 242,655 tons in 1933. Coal bunkered was 93,079 tons, as against 80,818 tons in 1933.

Bus Building in the Union.

A new branch of industry will be established in South Africa if a recommendation of the Board of Trade and Industries is accepted by the Government. The Minister of Commerce and Industry, on January 21st, laid before Parliament the report of the Board on the free admission of metal skeleton framework for the bus-building industry. This report involves a departure in transportation, as it aims at the completion of trolly-buses in the Union with South African labour and South African material. The Board of Trade has recommended that the skeleton framework of these buses should be admitted free of duty for a period of sufficient duration to enable the tramway companies and municipalities to gain experience and to train labour for the complete production of bus bodies in South Africa. Cape Town, East London, Durban, and Johannesburg, are putting this type of bus into service, and it is understood that they will all take advantage of the new facility.

South-West Africa Air Service.

The South African Airways took over from South-West Africa Airways on March 1st. The present single-seater machines will be replaced by Junkers five-seater cabin monoplanes. A weekly service will be inaugurated between Windhoek and Cape Town, connecting both ways with the mail steamers and leaving Cape Town Monday, returning Friday. For this service a new fast plane with a cruising speed of 185 m.p.h. is expected to arrive shortly. It will bring Windhoek within six hours of Cape Town. In the Union itself, the South African Airways are expanding their services. There are to be two flights to Cape Town each week, on Tuesday and Thursday mornings, from Johannesburg (Germiston Airport); the return trips will be on Fridays and Mondays. There is also to be a twice-weekly service between Cape Town and Durban. For this latter service the South African Airways have just ordered another three-engined "J U 52" machine, which is to be a seventeen-seater, with a Horne engine, and capable of 185 m.p.h. The machine will cost £25,000. British machines for the time being have lost all share in any of the Airways' orders.

Railway Estimates.

The estimates of expenditure on the South African Railways and Harbours for the financial year ending March 31st, 1936, show that the amount is expected to be £30,762,883, or £3,264,246 above the expenditure in 1934–35. There is an increase of £400,373 for maintenance of rolling stock, while an amount of £500,000 represents a first contribution towards the establishment of a Wages Stabilisation Fund. The vote of £88,531 for Airways shows an increase of £38,263, which is required to cover increased cost of operating the larger and speedier type of aircraft (German) now in service.

New Whale Catchers.

Apparently the companies interested in whaling have little fear of a slump in whale oil, for new factory ships and new whale catchers are being ordered each year. There has just been placed in Norway an order by a Cape Town firm—Irwin and Johnson—for three oil-burning whale catchers. These will develop 1200 h.p., compared with 850 h.p. by other vessels of the fleet, and be 12ft. longer.

Cape Town, March 15th.

Union Industrial Progress.

In its report of Customs tariff amendments for 1935, the Board of Trade and Industries states that a complete recovery from the depression has taken place, and there is every indication that the record of 1929, the previous best as far as industrial activity is concerned, has already been exceeded. Analysing the indices of industrial activity, based on employment in the five big industrial centres, combined in all selected industries, it may reasonably be concluded that during 1934 secondary industry completely recovered from the depression. Employment has increased at a very fast rate. This must largely be attributed to the increased industrial employment on the Rand. For the five industrial centres combined, the index for European employment in September, 1934, at 125 indicates an increase of 25 per cent. on the basic month of July, 1925; 7·7 per cent. on the monthly average of 1929, the pre-depression peak year of industrial activity; 34·4 per cent. on the figures for July, 1932, the depth of the depression; and 16·8 per cent. on the figures of September, 1933, when gradual recovery had been in progress for little more than a year. The report adds that from the Board's knowledge of industrial conditions, including development of new industries, it may be concluded that with the continuance of sympathetic treatment of industrial enterprise, as well as favourable conditions in mining, together with material improvement in agriculture, industrial activity in 1935 will exceed that of 1934. One of the most encouraging features of the trend of industrial development is found in the fact that the ratio of European employment in private industry has reached the figure of 41·5 per cent., compared with 34·9 per cent. for the 1924–25 industrial census and 37·6 per cent. for the 1929–30 census. The Board recommends increases in Customs duties on hides, boot and shoe uppers, women's dresses, and superphosphates, and decreased duties on steel strip, woollen piece goods, air survey films, calcium cyanide, and steel golf shafts.

New Torbanite Factory.

The South African Torbanite Company, Ltd., has acquired land in the industrial township which the Boksburg Municipality has created, and the building of factories will start immediately. It is claimed by those interested in the new enterprise that petrol will be manufactured from the torbanite deposits which have been acquired in the Union at the exceedingly low price of 2d. per gallon, and it is expected that motor cars will be running on this petrol before the end of the year. At Ermelo, where the torbanite deposit is situated, men are at work excavating foundations for the crude oil plant which is to be erected there, while the refining plant will be at Boksburg. It is anticipated that 6,000,000 gallons of petrol per annum will be turned out by the plant for a start, and it is expected that the output will be substantially increased before long. The Government is stated to have given an undertaking to protect the new industry against unfair competition, such as dumping, and any undue competition which might result from the establishment of refineries in this country for converting imported crude oil into petrol. But there are a number of other factors, which the industry will have to take into account, and which will seriously affect the price calculations. The annual importation of petrol into South Africa is well over 80,000,000 gallons per annum, and on this the Government collects a duty of 6d. a gallon and a further ½d. for harbour dues, the two giving the State revenue of well over £2,150,000. The Government will expect to collect a similar duty from the new private enterprise, which it could not be expected to favour to the extent of depriving the State of over £50,000 per annum. As local oil distributors estimate the charges in Cape Town at 4d. a gallon, this including distribution to points within a radius of 50 miles from the city, and evaporation losses in transit, and there are also the freight charges on the petrol brought down here from the Boksburg refinery—about 7d. per gallon—making the total cost of torbanite petrol up to 1s. 7d. per gallon, very little, if any, will find a market in the Cape Peninsula, where the price of imported petrol is 1s. 7d. per gallon to-day and is usually less. It is possible, however, that torbanite petrol will replace imported petrol on the Rand and in the neighbouring districts, for it can be delivered there free of freight charges, while the imported spirit will be handicapped by these charges. Analyses of the Ermelo torbanite deposits are said to yield about 90 gallons of petrol to the ton. It appears from analyses at different points that this is likely to be an outside figure, though claims for up to 120 gallons have been made in regard to samples from other points. Taking the figures furnished by several expert engineers, and as many geologists, some years back when efforts were made to establish an industry to produce petrol from Union torbanite deposits, it would appear that there is not more than enough torbanite in all the deposits to supply the petrol requirements of this country for more than ten years. However, as the present concern only starts with the modest output of 6,000,000 gallons a year, it should run for very many years, provided, of course, that the cost of production of the refined petrol has been correctly arrived at.

Railway Electrification.

In delivering his Railway Budget speech, the Minister of Railways made a statement with regard to the electrification of the railways of the Union, and said that during the year ending March 31st, 1935, the electrification of the section of the Daimana–Harrismith, as well as of the Cape Flats line, was completed and electric working introduced. It was also decided to electrify the whole of the Natal main line from Durban to Volksrust—a portion was already done—and it is anticipated that the greater portion of this work will be completed by 1936. Consideration is at present being given to the question of electrifying the lines in the Witwatersrand area. Development in this industrial area is of such a nature that it will be necessary to consider schemes of great magnitude to be able to cope with the ever-increasing traffic difficulties. The Minister mentioned that the Department had succeeded in reducing the cost of electrification by 30 per cent., as compared with the cost of the first electrification scheme, viz., from Glencoe to Pietermaritzburg. The Minister further stated that the report of the Granet Commission, which investigated the general railway policy, was a valuable document, and contained, particularly as regards technical matters, suggestions calculated to bring about considerable economies, as well as an increase in efficiency. The gradual application of many of the recommendations of the Commission is being considered at the present time. The report of the Nijhoff Commission contains very pertinent observations with regard to our harbour system as a whole, and may lead to a reorganisation, whereby the harbour administration will be rendered more independent, and consequently less subject to railway policy. The report also contains recommendations in regard to the different harbours of the Union, which serve as a valuable test for schemes which the department has had under consideration for some time. Advantage is to be taken of the improved financial position to effect a further speeding up of the train services. The Minister appears to be somewhat apprehensive of a setback to the improving position for he said the reason the railway staff and the public did not get more was that there was no guarantee that the railways would not suffer such a setback during the next two years. A drop in the price of gold, a setback in overseas markets, droughts, or other external difficulties, could change a surplus into a deficit in a few months' time, but he hoped and expected that those possibilities would not materialise.

A New Steel Industry.

Another big overseas industry is coming to South Africa. The first plant for the manufacture of steel chains will be set in motion shortly at Vereeniging, Transvaal. One of the largest producers in the world, the Columbia and MacKinnon Chain Company, of St. Catherine's, Ontario, Canada, has completed negotiations for the erection of a branch works on a site near the Vaal River, thereby giving the Union an entirely new product. Work has already been started on the buildings, and the manager of the enterprise has returned to Canada to report developments, but will be back in the Union in a few months' time. No protection has been asked for by the Columbia-MacKinnon Company, which will secure its raw materials from the Union Steel Corporation at Vereeniging, which is associated with the Iscor (Industrial Steel Corporation) Works at Pretoria. Production from the beginning will be at the rate of 1000 tons yearly, and this is to be doubled very soon. Semi-automatic electrical machinery is to be used for forging the links, involving the employment of highly skilled men. Most of the, about sixty, Europeans to be employed will be South Africans, and there will also be some dozens of natives. Experts from Canada will shortly arrive to teach the South Africans their work. Motor car chains will be one of the chief products of the company, also chains for trek wagons—a big speciality in South Africa. On the mines large quantities of chains are used as safety devices in shafts, and there is a further demand for lifts in buildings. If necessary, the works will also make handcuff chains for use by police on prisoners. Engineers, it is stated, consider this one of the most important of the subsidiary industries founded since the opening of the Pretoria Steel Works.

SIXTY YEARS AGO.

Our issue of April 9th 1875 is singularly full of inventions, ideas and proposals which came to nothing in the end. In one of our leading articles for instance we discussed the construction of a Channel tunnel—the scheme was then at the crest of one of its periodic recurrencies—and virtually condemned it because of the almost insuperable difficulties which we foresaw in keeping it properly ventilated. The only way which we considered would be practicable would consist of the employment of fireless locomotives fitted with condensers. Such a locomotive, capable of performing the journey would, however, weigh about 80 tons or considerably more than the train which it hauled. It is possible that our suggestion for the use of fireless locomotives was inspired by an article appearing elsewhere in the same issue in which we described a hot water self-propelling tramway car invented by Mr. L. Todd of Leith, a well-known pioneer of mechanically propelled road vehicles. Mr. Todd's cars were to be provided with receivers to contain a supply of hot water under a pressure of 200 lb. which would give off enough steam to propel the vehicles for a few miles. At the end of each journey the car was to return to its shed to be connected to a boiler which would replenish the supply of hot water in the receivers. The inventor claimed that his car was completely safe against explosion. Indeed he boldly named it "The Harmless." From Mr. Todd we may pass to Mr. E. J. Reed and pursue the remarks which he made in a paper before the Institution of Naval Architects on the Bessemer cross-Channel steamship. At that date the vessel had been completed and had undergone three trial runs including a voyage from the shipyard on the Humber where she was built round to the Thames. The two pairs of paddle wheels driven by independent engines had, it seems, confounded the critics. The after wheels contributed their fair share to the propulsion of the ship and speeds of 16 knots had been reached. Judging from Mr. Reed's account we ought to believe that the design of the ship defeated the end for which she was built. She was so steady, both as regards pitching and rolling, that no real opportunity for demonstrating the merits of her swinging cabin had been presented. In a second leading article we discussed a new bronze alloy hydraulically compressed which the director of the Vienna arsenal had produced. The metal was stated to be so promising that the production of steel guns might soon be abandoned. In a third leading article we dealt with another aspect of current artillery practice but in this case, it must be confessed, the point involved was the support of a lost cause rather than the promulgation of fruitless ideas. Questions had been asked in the House of Commons on the vexed subject of breech-loading *versus* muzzle-loading heavy guns. All the chief Continental nations were busy on the development of breech-loaders but we maintained that they were only passing through a period of experiment which this country had emerged from some years previously. They would find, we said, as we had found that although breech-loading might be better than muzzle-loading the world had yet to learn how to make a breech-loading gun which would on the whole be as good as a muzzle-loader.

Several railways have recently been conducting experiments with tire treads of various tapers. The Northern Railway of France, after trying parallel, 1 in 20, and 1 in 40 taper treads, has fitted the last-named to a few steam locomotives, and to the triple-car, oil-engined trains operating on 60 m.p.h. schedules between Paris, Amiens, and Arras, and the Danish State Railways have adopted the same taper for the new 1100 b.h.p. streamlined oil-electric trains which are to maintain mile-a-minute timings between Copenhagen and Esbjerg and Copenhagen and Aarhus. These experiments recall the parallel treads used almost fifty years ago by Mr. Stroudley for his front-coupled engines, but in those engines the flange was only ¼in. thick.

High-Pressure Marine Boilers.*

(*Continued from page 368.*)

THE SULZER SINGLE-TUBE BOILER.

By J. CALDERWOOD, M.Sc.

THAT there is scope for improvement in boiler design is shown by the number of manufacturers who have carried out extensive research during recent years in the development of new designs in an attempt to overcome the limitations of the drum-type water-tube boiler with natural circulation. It is evident that in the normal types of water-tube boiler further development to higher pressures and steaming rates is limited first, by the increasing weight and cost of the drums for higher pressures, and secondly, by the liability to poor circulation due to the higher density of the steam. A drum-type boiler is further limited in the possible arrangement of tubes, and consequently it cannot be adapted to the varying space requirements that have to be met for different services. It is largely for these reasons that pressures have not exceeded about 500 lb. per square inch for marine services, and have only risen to about 1000 lb. per square inch in exceptional cases on land, and then only for very large boilers. It is evident that in many cases both on land and sea there would be a gain in efficiency by the use of higher steam pressures, but even more important in the search for new types of boiler is the requirement that they should be lighter and more compact than existing types, and should be adaptable as regards shape to meet the space available for various services.

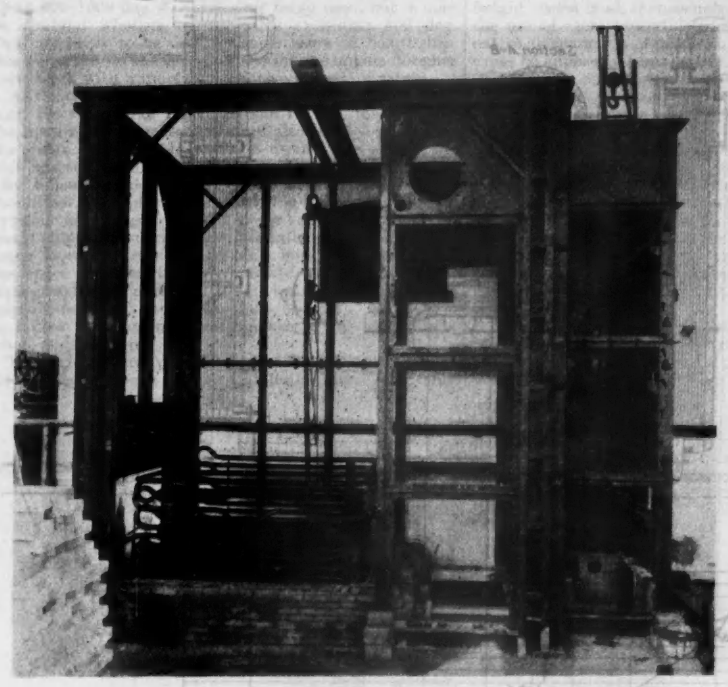
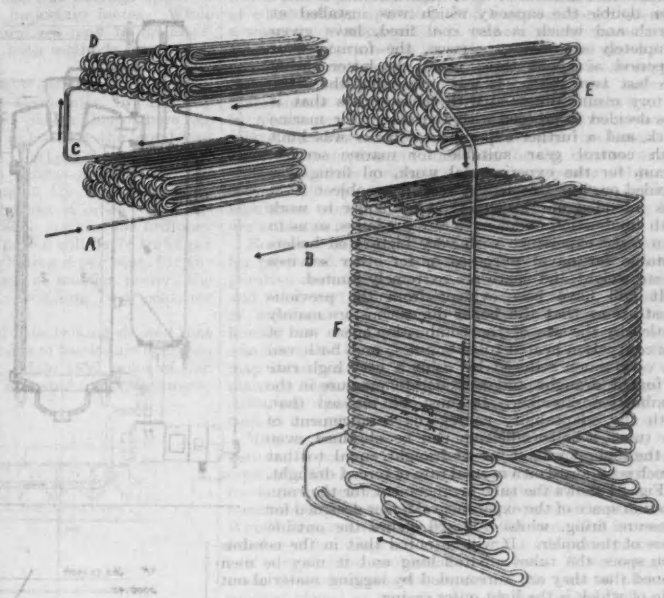


FIG. 21—"*Monotube*" *Boiler under Construction. Designed for 17,000 lb./hr. at 1,500 lb. per sq. in.*



A—Feed-Water Inlet.
B—Superheated Steam Outlet.
C, D, E—Tube Bundles which can be Arranged to Suit Space Available.
F—Tube Lining of Combustion Chamber.

FIG. 23—*Tube System of "Monotube" Steam Generator.*

Some years ago the author's firm started research on high-pressure boilers. The first boiler built was a single-drum boiler with hairpin tubes. This boiler was designed for a pressure of 1500 lb. and proved very satisfactory. The design, however, was not proceeded with for these high pressures on account of the fact that it still suffered from the disadvantage of having the expensive high-pressure drum and also from some restriction on the tube arrangement that could be adopted, although this restriction was perhaps not so marked as with many drum-type boilers. It was evident that some more flexible type of boiler as regards arrangement must be adopted, and it appeared that the most promising line was to attempt to develop what has in the past been known as the flash boiler, viz., a boiler consisting simply of a long coil of tube into which water is pumped at one end and from which steam at the required conditions issues from the other end. The troubles experienced with these boilers were, however, well known, and it was necessary to start on extensive experiments to determine how these troubles could best be overcome. For this purpose test boiler plant was laid down in 1927. The test boiler was oil fired, as it was evident that oil firing lent itself most readily to adjustment for the purpose of experiment, but the experiments were undertaken with a view to the boiler eventually being designed for coal firing.

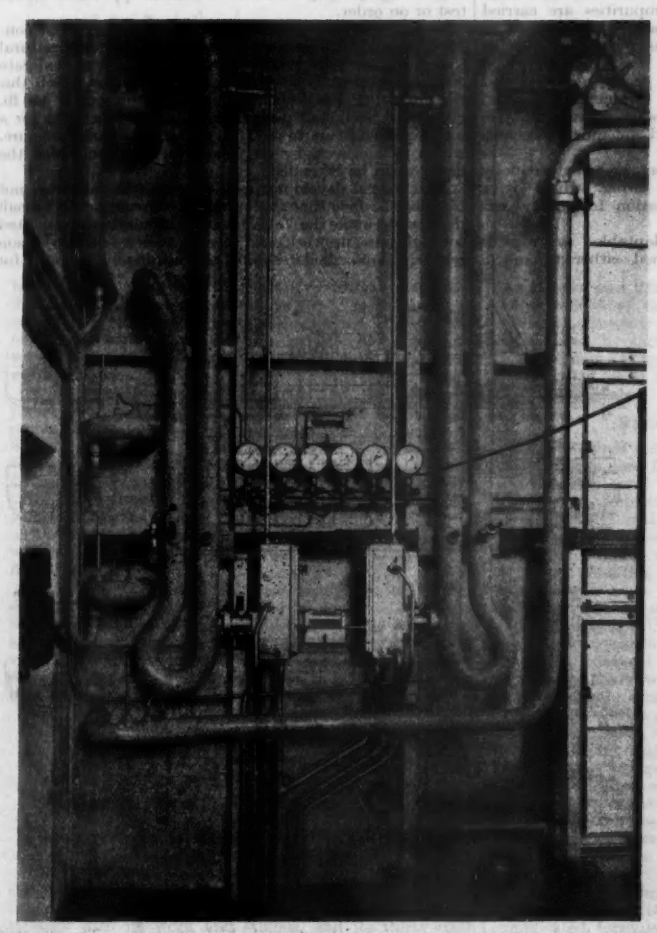


FIG. 22—*View on Side of 17,000 lb./hr. Boiler Showing Thermostat Controls.*

From the experiments on this boiler were evolved the conditions necessary to ensure satisfactory operation of the single-tube boiler. These were found to be:—

(1) Tube length of the order of 30,000 times the internal diameter of the tube, or roughly half a mile per inch tube diameter.

(2) A high velocity through this tube giving considerably higher feed pump pressure than steam pressure.

(3) Thermostatic regulation of the rate of feed from the steam temperature.

(4) Secondary feed injected at a point in the long tube about that at which the steam becomes dry saturated.

The main features of the boiler and the controls were very fully described in an article by Professor Dr. A. Stodola, which was published in THE ENGINEER on November 17th and 24th, 1933. Although on paper this control mechanism may sound somewhat complex, it is in practice very simple, and is a substantial oil servomotor type of equipment which can be considered as a sound engineering job. For a marine unit the regulating equipment required is simpler than for a stationary plant, as in the latter the load fluctuations must all be met automatically, whereas for marine service the engineer on watch can control the load. For manœuvring in marine service it is, of course, necessary to provide for a by-pass direct to the condenser so as to avoid blowing off steam through the safety valve each time the machinery is stopped.

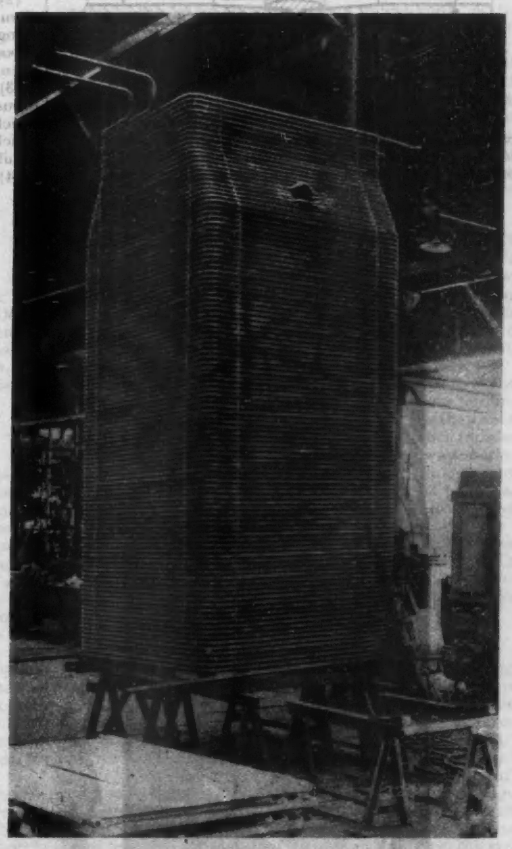


FIG. 24—*Combustion Chamber for Marine Boiler; 23,000 lb./hr. Steaming Rate.*

The satisfactory results obtained on the test boiler led to the installation in 1932 of a coal-fired boiler in a factory in Winterthur. This boiler has a capacity of 17,000 lb. of steam per hour, a normal working pressure of 1500 lb. per square inch, and a normal steam temperature of 750 deg. Fah. The boiler under construction is

* Symposium, Institute of Marine Engineers, March 12th, 1935.

illustrated in Fig. 21, whilst Fig. 22 is a side view of the boiler showing the thermostat.

The arrangement of the tube bundles for a somewhat similar boiler is shown in Fig. 23, which illustrates the flexibility of the boiler from an arrangement point of view, as it is evident that the tube bundles *C*, *D*, and *E* in this illustration can be disposed as found convenient according to the requirements of space. The shape of the tubes comprising the radiant heat surface *F* is, of course, fixed by the fuel and method of firing, as these tubes comprise the combustion chamber of the boiler.

The boiler illustrated above and another of more than double the capacity which was installed at Zurich and which is also coal fired, have given completely satisfactory service, the former over a period of about three years, the latter during the last two years. It was only after the satisfactory results obtained with these boilers that it was decided to proceed with the design for marine work, and a further experimental boiler was built with control gear suitable for marine service. Again, for the experimental work, oil firing was decided on, but this had a secondary object as it was intended on the experimental boiler to work with combustion under moderate pressures, so as to gain some experience with very high-rated boilers suitable for naval purposes or for other services where weight and space are extremely limited.

It will have been evident from the previous illustrations that the boiler dimensions are mainly settled by the size of the combustion space and of the convection heated tube bundles, and both can be very much reduced by using a very high rate of forced draught and a moderate pressure in the combustion chamber. It must be realised that, with the adaptability as regards arrangement of the tubes, a boiler efficiency can be obtained, even at the highest rate of forced draught, equal to that which is obtained on a normal rate of forced draught.

Fig. 24 shows the tube arrangement for the combustion space of the experimental boiler designed for pressure firing, whilst Fig. 26 shows the outside view of the boiler. It will be noted that in the combustion space the tubes are touching and it may be mentioned that they are surrounded by lagging material outside of which is the light outer casing.

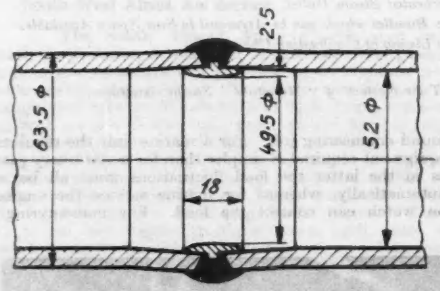


FIG. 25—*Welded Joint Used in Construction of "Monotube" Boiler.*

Most satisfactory results have been obtained with the experimental marine boiler and work on the first installation for a ship is now proceeding. This is the ss. "Kertosono," of the Rotterdam Lloyd Line. In this vessel one Scotch boiler has been taken out and replaced by a Sulzer monotube boiler, which will generate the same power as was previously done by five Scotch boilers of similar size to that replaced by the high-pressure boiler.

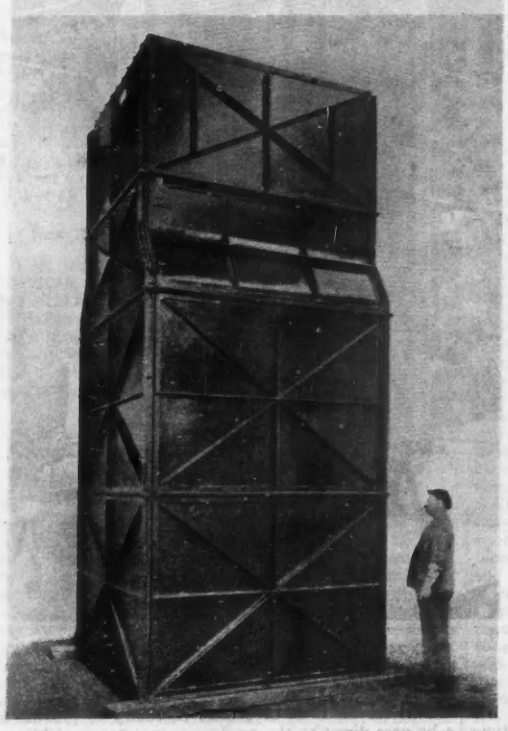


FIG. 26—*Marine Type "Monotube" Boiler Designed for 23,000 lb./hr. Steaming Rate with Oil Firing.*

To summarise the advantages of the monotube type of boiler:—

(1) The boiler is extremely safe against explosion, as the amount of stored energy is very low, the total weight of water in the boiler being only that contained in the tubes. Further, it will be seen from the next paragraph that the danger of tube failure is practically eliminated.

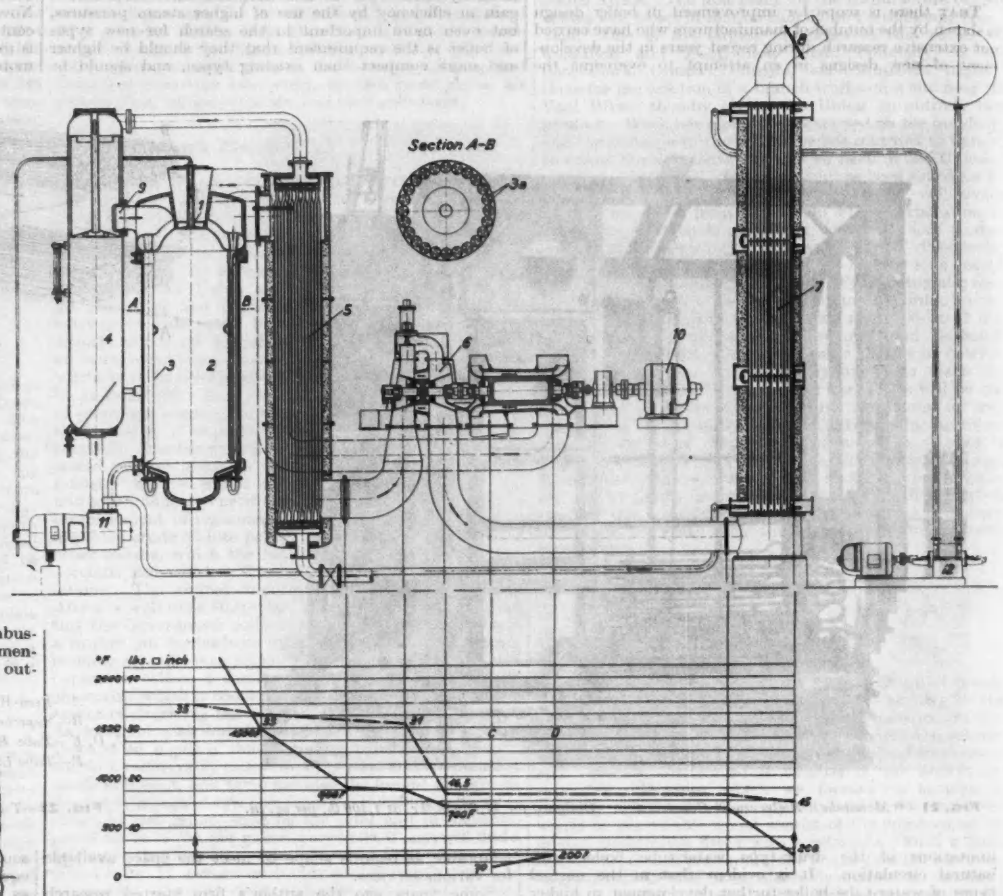


FIG. 27—*Sectional Arrangement of the Velox Steam Generator.*

(2) The circulation is absolutely positive and the rate of circulation such that any slight impurities are carried along with the mixture of steam and water instead of depositing out as would be the case with a low rate of circulation.

(3) The boiler and its control gear are simple and robust, and there is no special equipment involved which is liable to raise difficulties in service or with which the seagoing engineer would not quickly become familiar.

(4) Due to the method of regulation, the boiler is equally suitable for coal or oil firing, which is a most important consideration for many services.

(5) The boiler is adaptable as regards space. It can be designed either to suit a very short boiler-room, where head room is not important, or alternatively can be arranged as a horizontal boiler where head room is of vital importance.

(6) As compared with any type of boiler involving drums or headers, it must be lighter, as the total tube surface required is actually less and, in addition, the weight of the drums or headers is saved.

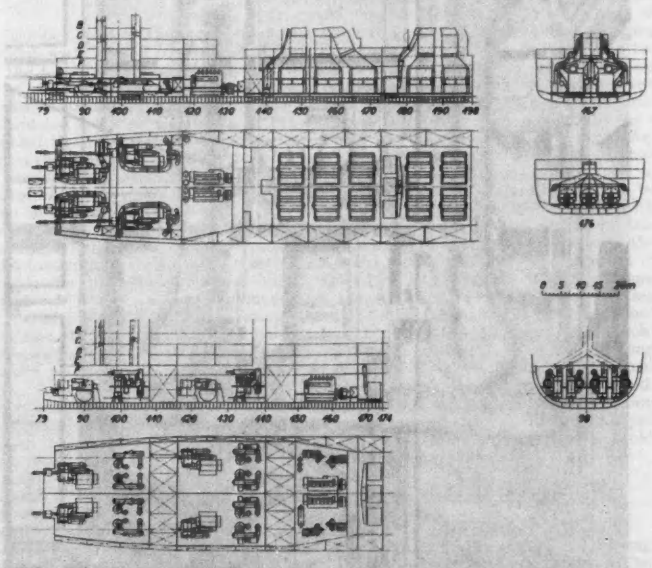
THE VELOX STEAM GENERATOR.

By M. G. S. Swallow.

During 1933 and 1934 we have seen the advent of the Velox steam generator as a commercial boiler. It is now being used in a number of industrial steam plants on land, and certain naval Powers have marine type units under test or on order.

In the case of a new boiler such as the Velox, not confined to any particular pressure range, it is only natural that the first units should have been built for moderate steam pressures. The maximum pressure for which this type of boiler has been built up to the present is 640 lb. per square inch, but designs have been worked out for a unit operating up to 800 lb. per square inch pressure, which is, however, by no means the limit to which the designs can be extended.

This logical development of a new invention must not obscure the fact that the tubular construction and small dimensions make the Velox boiler particularly well adapted for high-pressure work, and there is no constructive reason why the Velox boiler should not ultimately be built for steam raising at extremely high pressures. The structure of the boiler is particularly well adapted for such pressures, as there is, for instance, no drum in contact with the flame, and, as generally understood, no steam or water drums are in use. The separator, which is of drum design, is relatively to the whole plant of such small dimensions that there is no structural difficulty in building a drum which is only subject to the boiler pressure and the temperature of the water corresponding to the temperature of saturated



S.S. "Conte di Savoia" with Existing Boilers

S.S. "Conte di Savoia" Arranged for "Velox" Boilers

FIG. 28

steam. All the heating surfaces where steam is generated are tubular and the heating elements are built up of simple components, and what is even more important, there is uniform and symmetrical distribution of material.

For marine installations it is, however, not so much a question of the maximum pressure at which a boiler can be built, but rather the most economical pressure and steam cycle for any particular installation. Conditions on board ship impose certain limitations which do not exist, or only in a less acute form, on land installations, and it can be stated generally that the optimum steam pressure is likely to differ very considerably in the two cases. For a stationary plant, live steam temperatures up to 900–1000 deg. Fah. are now being used, but it may be doubted whether temperatures exceeding 800 deg. Fah. are likely to be used for some years on board ship, this being due to the fact that the marine engine designer must work with a more conservative margin of safety.

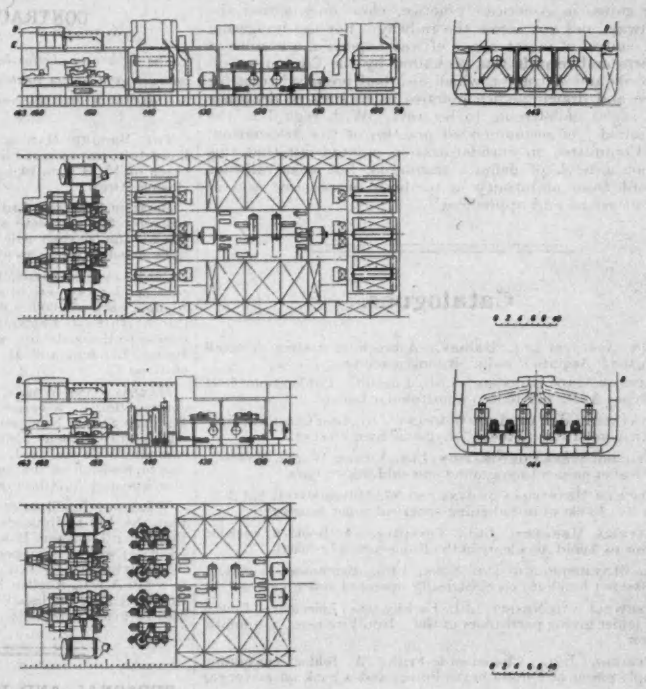
As the condition of the steam at the exhaust end affects both the running of the plant and its life, the fixing of the maximum steam temperature also implies a limit to the steam pressure. In addition to this, the size of the unit has to be considered. There is no technical reason why reheating and extensive regenerative feed heating should not be employed on board ship (both with thermodynamic advantage), but it must be kept in mind that on board ship particularly, space limitations generally are of much more importance than on a land installation, and the space required to accommodate reheat boilers and piping and large numbers of feed heaters may make the improvement in thermodynamic economy illusionary, as far as the economic performance of the vessel as a whole is concerned.

It can be generally assumed that the most economical steam pressure for a marine installation must inevitably be lower than for a stationary plant and it is questionable if a pressure in excess of 600 lb. to 700 lb. per square inch would be justified for propulsion units of 20,000 s.h.p. or over, whilst for smaller vessels the most economical pressure would probably lie between 400 lb. and 600 lb. per square inch.

With these pressures and adequate drainage of the low-pressure turbine blading, it should not be necessary to employ reheating, even with temperatures of 750 deg. or 800 deg. Fah.; nor particularly in the Velox boiler is excessive regenerative feed heating of any particular advantage, a feed temperature up to 180 deg. Fah. being sufficient to obtain an overall efficiency of the Velox steam generator, inclusive of all boiler auxiliaries and feed pump, of the order of 90 per cent. under full load conditions, whilst the efficiency remains practically constant at this figure down to half load.

An installation on these lines, whilst giving a high overall efficiency, would at the same time occupy a minimum amount of space and have the additional advantage of considerably reducing the high-pressure steam pipe lengths and joints, the maintenance of which, with high pressure and temperature, is of greater importance in marine than in land installations.

(To be continued.)



S.S. "Manhattan" with Existing Boilers

S.S. "Manhattan" Arranged for "Velox"

FIG. 29

Convention of the American Railway Engineering Association.

NOTWITHSTANDING the long-continued depression and the very unfavourable situation of American railways, the American Railway Engineering Association has proceeded steadily with its work and studies, and its thirty-sixth annual meeting—held at Chicago in March—showed a large increase in attendance beyond that of the past few years, with a registration of some 560 members and visitors.

Of great practical importance was the resumption of the exhibition of railway equipment and appliances, held at the Coliseum, the Manufacturers' Association having decided that conditions would warrant this, after an omission of four years. While not as large as in some previous years, it was both extensive and comprehensive. Two outstanding features were heavy track construction with points and crossings of 131 lb. rails, and a great number and variety of power-operated tools and appliances for railway maintenance work.

RAILWAY OPERATING ECONOMICS.

From a study of the merits of ruling gradients less than 0·4 per cent., in the light of modern operating requirements, the Committee on Economics of Railway Location suggested 0·2 per cent. as a limit below which reduction of gradient would not be economical. Weight and number of trains are primary considerations, but average speed of freight trains is an increasingly important factor. While the use of more powerful locomotives may be an alternative to reduction of gradient, both methods may sometimes be applied in combination.

In a report on the more extensive use of existing railway facilities, the Committee on Economics of Railway Operation instanced a case of two parallel lines where one was abandoned for nearly 10 miles and the combined traffic was handled on the other. Certain new connections were required, with changes in sidings and signals, but there was a very marked saving in the annual working expenses. With reference to the use of oil-electric locomotives, it was stated that in such engines for ordinary train service the nominal horse-power will be 78 to 82 per cent. of the engine capacity, including 4 per cent. for the auxiliaries. In shunting engines, of smaller power, the figure will be 73 to 77 per cent., including 7 per cent. for the auxiliaries.

The Committee on Signals and Interlocking showed that 8573 miles of line—with 15,890 miles of track—are operated under automatic train control; while 1891 miles of line—with 4345 miles of track—are operated under automatic cab signals, and 9225 locomotives are equipped for train control—3086 of these with cab signals only. Of the central traffic control system—in which train movements are directed by signals operated from a central point—there are now 141 installations on forty-one railways, with 1677 miles of track, 969 points, 781 semaphore signals, and 2388 light signals.

BRIDGES AND BUILDINGS.

The standards and recommended practice of the Association are revised from time to time to keep abreast of developments, and an important step taken was the adoption of completely revised specifications covering the design of, and materials for, steel railway bridges not exceeding 400ft. in span. The new live load assumed is 36 net tons on the driver axles of eight-coupled engines, 18 tons on a leading axle, and 24 tons on the tender axles, followed by a train load of 7200 lb. per lineal foot. The Committee on Iron and Steel Structures also discussed the strengthening of bridges, to provide for heavier live loads or to compensate for local deterioration at certain parts or details. Several individual papers submitted by the Committee dealt with:—Changes in the character of structural steel; a new column formula; shear on column lacing; the elastic stability of plates subjected to compression and shear; net section of riveted tension members; tests on bridge expansion rollers; and live loads for multiple track bridges.

Timber trestles—and timber bridges to a less extent—being still extensively used, the Committee on Wooden Bridges and Trestles submitted a revision of rules for the grading or classification of structural timbers according to strength and stress. There were proposed plans also for timber road bridges over railway tracks, with both plank and concrete flooring; also for railway trestles designed to carry the live loads mentioned above. A somewhat complicated formula was proposed for determining the comparative economic value of steel, timber, and reinforced concrete for bridges and trestles, with due regard to durability and obsolescence. A report on the waterproofing of concrete slabs, abutments, retaining walls, and other structures dealt particularly with bituminous emulsions, which have an important advantage, in that they can be used cold and may be applied to damp or wet surfaces.

Specifications for the making and driving of concrete piles and for the design of reinforced concrete arch spans were presented by the Committee on Masonry, together with plans for concrete trestles—36-ton axle loads—composed of piles and pre-cast slabs 17½ft. long. It also discussed the placing of concrete by pumping and by compressed air, the latter method employing the "cement gun." The excess cost of drawbridges as compared with fixed bridges over navigable waterways was considered by the Committee on Waterways, as well as the economic aspect of increasing the height of fixed spans so as to avoid the use of opening spans.

It was held that when a railway—or road authority—builds a bridge over a waterway it should assume the cost of construction, operation, and maintenance. But when a waterway authority builds a new channel across a railway or road, or when it widens and alters an existing channel, the waterway authority should assume all expense for the necessary construction and alterations, including maintenance of any bridges. These conditions have arisen in recent years in connection with the development of inland waterways. As a different subject this Committee presented complete specifications for the construction of willow mattress protection for river banks subject to erosion. Such construction is commonly used on river regulation work and is used also by railways whose lines are adjacent to river banks where erosion occurs.

Economic and practical aspects of fender construction for piers and quays were discussed, as well as the comparative cost and life of ore loading piers of timber, steel, and reinforced concrete on the Great Lakes. The design of industrial buildings of heavy timber construction—known as mill type or fire-resistant construction—was discussed by the Committee on Buildings. The floors may be of concrete, or of a laminated construction, with plans on edge and spiked together to form a solid flooring. Attention was called to the increasing use of metal connectors in timber framing to develop shear resistance.

Making buildings proof against rats, termites, and vermin, to prevent damage to the structure and contents, especially foods in storage, depends largely upon effective methods to prevent their entrance into the buildings. The termite situation was discussed also by the Committee on Wood Preservation, which pointed out the increasing number of buildings attacked, so that adequate protection is a very definite problem to be solved. The Committee made its annual progress report on the tests of piles and timbers placed at various ports in the United States and foreign countries to determine the efficiency of different kinds of woods and preservative treatments in resisting the attacks of borers. For the prevention of termite attacks on telegraph poles, experiments have been made in poisoning the adjacent ground by various chemicals, but so far the results are doubtful.

STATIONS AND FREIGHT YARDS.

Passenger station design—mainly for large terminal stations—has been handled pretty thoroughly by the Committee on Yards and Terminals, but under present conditions this is a matter of little practical concern although there is a project for another great union or joint station at Chicago to take the place of four old stations. On the other hand, much is being done to improve the design and operation of freight yards, particularly to expedite movements through the yards. Co-ordinated operation of individual yards at large cities, as more economical and effective than competitive operation and much duplication of effort, is another problem for consideration. The Committee dealt with rail-and-water terminals and also the rail facilities serving grain elevators. Car retarders or track brakes, in 1934, were in operation in thirty-seven yards of twenty-one railways, according to the Committee on Signals and Interlocking. The equipment included 1020 retarders, 1125 classification or sorting tracks, 1125 switches, 565 rail skate machines, and 92 control stations.

As to the relation of motor truck competition to the planning of railway freight terminals, it appears that the motor truck industry is unstable; it suffers from a diversity of ownership and an excessive number of small concerns; there is lack of uniform regulation and taxation in the several States, but some form of regulation by the Federal Government is probable, so that substantial changes in the industry are to be expected.

Motor coach service is developing rapidly as a new phase of transportation, but monumental or elaborate terminals for bus lines are not required by the public, as they are for railway terminals. Plans were submitted for bus terminals in connection with and independent of railway stations. Important requirements are provision for through movements, free from backing and turning of the buses, and provision for loading and unloading under cover at such terminals.

In concluding this running review of the technical proceedings of the Convention, it may be pointed out that only brief summary and comment is practicable, in view of the great number of subjects presented by nearly thirty working committees.

SHOPS AND RUNNING SHEDS.

Carriage and wagon painting shops were discussed in a report which recommended separate buildings for the two classes of rolling stock. In general, the longitudinal arrangement is preferable to the transverse arrangement, the latter served by a transfer table. Cars should be cleaned and prepared outside, but special provision be made for moving steel cars into the paint shop as soon as they are cleaned. Reclamation plants for the salvaging of scrap material should be situated adjacent to the scrap yard. In a typical plant, the scrap yard is served by overhead travelling cranes of 10 to 15 tons capacity, the crane girders having a cantilever extension which overhangs the reclamation plant, so that the crane magnets can deliver material directly from the scrap yard to the reclamation platform.

Running sheds of the circular or segmental "roundhouse" form are generally preferable in American practice, but the rectangular form is adapted to meet certain special conditions. The design and equipment of running sheds were the subject of a report. For turning long locomotives, a turntable of the three-point bearing type is an advantage, as it does not require the engine to be balanced in position. Where the balanced type of turntable is used it should be long enough to balance the engine when the tender is empty.

Treatment of boiler water has been a subject of close study for several years by the Committee on Water Service and Sanitation. Its report of 1935 reviewed the advantages and disadvantages of zeolite treatment; also the economic value of water treatment in reducing the pitting and corrosion of boilers, as well as in extending the life of fire-boxes owing to the less frequent blowing-down and washing-out of the boilers. From tests of track tanks or water tanks laid between the rails, it has been concluded that such tanks should be 8in. deep and 19in. wide, with top angles having the flanges turned inward to check spilling of the water. The top of tank should be 1in. below the top of the rails, with water level 2in. below the top of the rails, and the tender scoop dropped 5½in. or 6in. below the same level. Train speed over a tank while the engine is taking water should not exceed 50 m.p.h.

Methods of malaria control were dealt with in the same report, which showed the former great prevalence of this disease among railway employees, and in the small towns which furnish railway labour. In the cities this disease has been almost eliminated, but the rural population from which railway labour is chiefly recruited, is said to be burdened in this way as heavily as it was fifteen years ago, although much improvement has been made in certain districts. In some of the Southern States the malarial death-rate has increased alarmingly in the past few years, and the railways will find it desirable to undertake its control, for both humanitarian and economic reasons.

Permanent Way.

From a study of the economic values of rails of different sizes and weights, in relation to varying densities of traffic, the Committee on Rails concludes that both stiffness of the rail and stiffness of the entire track structure—or permanent way—are of value in preventing irregularities in the track. However, the Committee has not yet been able to decide upon a money value for rail stiffness. A standard design of fish plate of the dumb-bell or ribbed section, for the Association's 131 lb. rail section, was adopted, together with new specifications for steel bolts for rail joints. The steel must have a maximum of 0·35 per cent. carbon and a minimum of 0·04 per cent. phosphorus, except that when high-strength nuts are specified the carbon will be between 0·40 and 0·55 per cent. For carbon steel, the ultimate strength must be 100,000 lb. per square inch; yield point, 75,000 lb.; elongation in 2in., 12 per cent.; and reduction in area, 25 per cent. Alloy steel must show 115,000 lb. ultimate strength, 85,000 lb. yield point, 15 per cent. elongation, and 35 per cent. reduction in area.

Service tests are to be conducted on a number of forms of joint bars on 112 lb. and 131 lb. rails, there being still great diversity of opinion as to the length and section of such bars. In fact, a major activity of one committee during the year has been a study of the design of the joint bar, with the effect of changes in section upon its properties and its value as a part of the joint. Special instruments have been devised for the measurement of cross sections and straightness in the bar and the rail. Of great importance also is a study of locomotive counterbalancing and other vertical and lateral forces of the wheels upon the track.

Another line of investigation is that of the complete track as a unit structure for various loads and traffic densities. This includes also the structures and the signal equipment. Three weights of rails are being considered—90 lb., 112 lb., and 131 lb. per yard—as these meet general traffic requirements, but for each of them there will be different types of track construction. Thus, with 90 lb. rails, certain densities of traffic or certain speeds will require stone ballast of certain depth, ties—or sleepers—of a certain class and spacing, and certain signal equipment or train control system. Other densities may justify the 90 lb. rails, but with less quantity of less expensive ballast, while automatic signals might not be required.

While rail lengths in excess of the present 39ft. standard are practicable and are in extensive use in other countries, the Committee finds it still undesirable to recommend a greater length. Besides economic factors, there are objections as to rolling mill conditions, cost, handling, and transportation, and the difficulty of establishing a standard length which will be permanent, so that the steel mills could adjust their plant facilities to the new conditions.

The continuing study as to the causes of and remedies for rail failures has included field investigations of dynamic wheel loads on 100 lb. and 130 lb. rails on the Baltimore and Ohio Railroad. The loads are those imposed by regular trains and also by a test train having flat spots of measured lengths on some of the wheels. Experiments are being made also with rails made by different controlled cooling processes to determine their effect in minimising shatter cracks in the steel. A new Sperry rail detector car—operated under the direction of this Committee—was put in service in 1934, together with a petrol-engined car to haul the detector car.

Sleepers—or ties—of steel and concrete are a negligible factor in American track construction, for though innumerable designs have been made and tried, the practical results are mainly unfavourable, while on an economic basis they do not compare with treated timber sleepers. A study of the economic length of sleepers was reported, showing that the almost universal 8ft. length is of purely arbitrary selection, and a greater length would give increased bearing support at little, if any, greater cost. A length of 8ft. 6in. is recommended, but some railways already use 9ft. sleepers, where the line is on soft ground. Annual statistics as to the behaviour and life of treated ties in certain sections of line under careful observation were presented by the Committee on Wood Preservation.

Recognising that an era of marked increase in speeds of passenger trains has begun, and that this condition has an intimate relation to the superelevation on curves, the Committee on Track has undertaken to revise the regulations for curve elevation, including easement curves or spirals. Its tentative tables cover elevations for ordinary and special high speeds, the maximum in the latter case being 9in. for speeds of 55 miles an hour on curves of 950ft. radius and 110 miles on curves of 4000ft. radius. For "comfortable riding" through turnouts or junctions, speeds recommended range from 25 miles per hour through a 1 in 10 crossing or frog, to 51 miles through a 1 in 20 frog. Complete instructions have been formulated for checking the accuracy of curves by the string lining method instead of the use of instruments. Another feature of the report was a series of detailed plans for points and crossings.

For the open joints in rails at the ends of drawbridges, the Committee recommended a maximum of ½in., unless special devices are used with carrier rails on which the wheel treads ride across the gap. On fixed spans, the joint spacing should be the same as on other parts of the track, but when additional expansion must be provided on long bridges, it may be taken up by the insertion of switch points and stock rails.

Maintenance of Way.

Several reports dealt with various aspects of the work of track maintenance, including the situation where maintenance work has been restricted below normal by reason of financial conditions. Special instruments have been devised for measuring the wear of rails at the joints. Power-operated machines for maintenance work include tractors of the "tank" type that can travel along or beside the track. Motor cars for permanent way forces are now pretty well standardised, and further improvements are expected to be in matters of detail rather than general design. It is evident that a considerable saving in maintenance work can be realised by welding the rail joints or using re-formed bars. A complete system of organising gangs for surfacing the line, using power tools and appliances, was outlined by the Committee on Economics of Railway Labour, the gangs ranging from 50 to 140 men. The possibilities of "out-of-face" renewal of track, or renewal of all its component parts at one time, are being studied. While this method is widely used in Europe, it is practised only to a very limited extent on American railways.

For the protection of level crossings there is reported a trend towards a decrease in the use of gates and watchmen, and an increase in automatic signals and devices. The gates, in American practice, close only across the highway, and not across the railway. For the budgeting and control of maintenance of way expenses, a system of reports and records was presented by the Committee on Records and Accounts, which also had prepared rules for office and drawing-office practice as to sizes of drawings and styles of lettering to be used. With regard to the "Manual" of recommended practice of the Association, the Committee on Standardisation pointed out that this is not a book of definite standards, but that railways benefit from uniformity in methods of practice and of specifications and appliances.

Catalogues.

Wm. Asquith, Ltd., Halifax.—A brochure dealing in detail with the "Asquith" radial drilling machine.

Ruston and Hornsby, Ltd., Lincoln.—Publication 6801 on types A, B, and K loco-multitubular boilers.

Staveley Coal and Iron Company, Ltd., near Chesterfield.—Particulars of the "Studus" hygienic floor cleaner.

English Steel Corporation, Ltd., Vickers Works, Sheffield.—A leaflet on precision ground and cold-drawn bars.

Fischer Bearings Company, 85–87, Milton-street, E.C.2.—List No. 1339a of self-aligning spherical roller bearings.

Alfred Herbert, Ltd., Coventry.—A booklet entitled "How to Avoid Accidents in the Engineering Industry."

J. Blakeborough and Sons, Ltd., Brighouse, Yorks.—Illustrated brochure on electrically operated sluice valves.

Ashwell and Nesbit, Ltd., Barkby-lane, Leicester.—Loose-leaf folder giving particulars of the "Iron Fireman" automatic stoker.

Ferodo, Ltd., Chapel-en-le-Frith.—A folder containing sample pieces of Ferodo brake lining, and a book on motor car brakes.

J. G. Smithson and Co., Ltd., Lifford-lane, Kings Norton, Birmingham.—Pamphlet on trigger-operated cam contactor controllers.

Marco Conveyor and Engineering Company, Lynn-road, Leytonstone, E.11.—A brochure on mechanical handling equipment.

Buell Combustion Company, Ltd., 49, Moorgate, E.C.2.—A brochure describing in detail the Buell pulverised fuel plant and equipment.

W. T. Henley's Telegraph Works Company, Ltd., Holborn-viaduct, E.C.1.—Catalogue WL2, giving the range of loop-in service cut-outs.

Geo. Bray and Co., Ltd., Leeds, 2.—Leaflet No. C. 148, describing the "Chromalox" finned strips for radiators and air conditioning plant.

Electric Furnace Company, Ltd., 17, Victoria-street, S.W.1.—Pamphlets on the Ajax-Northrop high-frequency furnaces and induction furnaces.

Woolaston Gas Producers (Manchester), Ltd., Tib-lane, Cross-street, Manchester, 2.—A booklet on the horizontal flame type of producer furnace.

David Brown and Sons (Hud'd.), Ltd., Huddersfield.—Particulars of a new range of tools and cutters tipped with "Cutanit" cutting alloy.

James Beresford and Son, Ltd., Birmingham, 7.—A pamphlet on the Beresford-Gardens submersible bore-hole centrifugal pump and motor units.

Switchgear and Cowans, Ltd., Elsinore-road, Old Trafford, Manchester, 16.—Particulars of three-phase metal-clad, oil-immersed, non-automatic switches.

Rotherham and Sons, Ltd., Coventry.—1935–36 catalogue of standard parts manufactured for the automobile, aero, electrical, engineering, and gas trades.

Sturtevant Engineering Company, Ltd., 147, Queen Victoria-street, E.C.4.—Publication No. 1492, dealing with the firm's system of electrostatic precipitation.

George H. Alexander Machinery, Ltd., 82, Coleshill-street, Birmingham, 4.—Particulars of the Loewe measuring device for worms, hobs, and similar cutters.

Birmabright, Ltd., Dartmouth-road, Smethwick, Birmingham.—A booklet on "Birmabright," a sea-water-resisting light alloy for shipbuilding and marine engineering.

Consolidated Pneumatic Tool Company, Ltd., 170, Piccadilly, W.1.—Publication 8P190, entitled "The Application of Mechanical Vibration to Concrete Construction."

Holden and Brooke, Ltd., Sirius Works, Manchester, 12.—List No. 167, dealing with the firm's "Super Selfix" circulators for forced circulation in hot-water-heating systems.

Sturtevant Engineering Company, Ltd., 147, Queen Victoria-street, E.C.4.—Latest catalogues listing the firm's products and pneumatic collecting and conveying systems.

Deloro Smelting and Refining Company, Ltd., 21, Hubert-street, Aston, Birmingham.—Catalogue and price list of "Stellite" high-speed cutting and hard facing alloy.

James Beresford and Son, Ltd., Cato-street Works, Birmingham, 7.—A number of illustrated leaflets describing the various types of "Beresford-Stork" centrifugal pumps.

Daniel Adamson and Co., Ltd., Dukinfield.—Publications T 200, "Turbo-compressors"; B 238, "Patent Super Lancashire Boiler Unit"; B 239, "Lancashire, Cornish, and Dryback Boilers."

Herbert Morris, Ltd., Loughborough.—The fifty-sixth edition of "Modern Lifting," a book of over 1100 pages giving an interesting description of the firm's works and fully illustrated particulars of the extensive range of lifting and conveying plant in which it specialises for all branches of industry.

Launches and Trial Trips.

Explorer, single-screw steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Charente Steamship Company; dimensions, 435ft. by 56ft. by 32ft.; to carry cargo and a few passengers. Steam Engines, triple-expansion; constructed by the Wallsend Slipway and Engineering Company; launch, April 2nd.

Duntroon, motor vessel; built by Swan, Hunter and Wigham Richardson, Ltd.; to the order of the Melbourne Steamship Company, Ltd.; dimensions, 470ft. by 65½ft.; to carry passengers and cargo. Oil engines of Burmeister and Wain-Kincaid type. Launch, April 4th.

Contracts and Orders.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The Brooke Marine Construction Company, Ltd., of Lowestoft, has received an order for the shipment of a further batch of 12/14 h.p., two-cylinder, high-speed Diesel engines to Buenos Aires.

British Timken, Ltd., of Birmingham, has received an order for 264 complete axle-boxes for the New Zealand Railways. The bearings will be of the tapered roller type, and are to be fitted to the axles of passenger coaches.

Crossley Brothers, Ltd., of Openshaw, have received a contract for two sets of six-cylinder, six-crank, vertical Diesel engines, each of 600 b.h.p. capacity, for the North Scottish and the North-East England B.B.C. stations. The engines are similar to those already installed by the B.B.C. at Broadcasting House, London, and at the Scottish and the West Regional stations.

Harland and Wolff, Ltd., have secured a contract for the construction of a cargo and passenger motor vessel for the Bombay Steam Navigation Company, Ltd. The new vessel, which will be about 250ft. in length, will be laid down at the company's Govan yard. The vessel will be constructed under the supervision of the owners' consultants, Messrs. McArthur, Morrison and Co., Glasgow.

Westinghouse Brake and Signal Company, Ltd., announces that the 120 trollybuses which are on order for the London Passenger Transport Board (68 Leyland and 52 A.E.C.-English Electric) will be equipped with Westinghouse air brakes. The 30 trollybuses now being constructed for Newcastle Corporation (10 A.E.C.-English Electric, 10 Guy, and 10 Karrier) and the 15 A.E.C.-English Electric for Bradford Corporation, will also be fitted with these brakes.

Personal and Business Announcements.

The Steel Barrel Company, Ltd., Uxbridge, Middlesex, has opened a provincial office to cater for the whole of the Midlands and the North of England, at 2, Bank-street, Sheffield, the resident manager in charge being Mr. F. C. Fieldsend.

Ferguson, Pailin, Ltd., Manchester, have recently opened a Midland office at Quality House, 25, Temple-row, Birmingham (telephone, Central 5431; telegrams, "Switchgear, Birmingham"). The office will be in the charge of Mr. J. Blount.

Thos. W. Ward, Ltd., of Sheffield, have purchased the Wreath Quay Engineering Works of MacColl and Pollock, Ltd., at Sunderland, on the river wear. The extensive plant, formerly used for marine engineering and boiler-making, is to be dismantled at once.

Vickers-Armstrongs, Ltd., have purchased the entire share capital of Palmers Hebburn Company, Ltd. We are informed that there will be no change in the management of the company, which will continue to be in the hands of Mr. E. L. Champness, as managing director.

Mr. Arthur Andrews, managing director of Drummond (Sales), Ltd., Birmingham, and a director of Drummond Brothers, Ltd., Guildford, has joined the board of directors of William Asquith, Ltd., and will take special interest in the sales policy and arrangements of that company. Mr. Andrews' company, Drummond (Sales), Ltd., has been appointed sole agents for William Asquith, Ltd., for Birmingham and the Midlands territory, and in addition sole agents for all users connected with the motor trade. These new arrangements have been made possible by the retirement of William Asquith, Ltd., from the sales organisation run by Associated British Machine Tool Mokers, Ltd.

Metal Rectifiers.—Owing to a typographical error in the notes on which the article on "New Applications of Metal Rectifiers," appearing in our issue of March 29th, was based, X-ray equipments were stated to have been made for 400-kW instead of 400 kV.

Hacksaw Frame.—We have received from Frys (London), Ltd., King-street, E.1, a hacksaw frame, Enox No. 18, which is just being put on the market. The frame is a single piece of flat steel bent into such a form that the blade forms the base of a long triangle. The short side of the triangle is armed with wood to make a handle. The blade is held by a pin at the forward end and by a screw with nut at the handle end. Tension is provided for by the spring of the frame alone, the blade being inserted with downward pressure on the handle. There are no loose parts bar the nut, which does not seem to be really necessary, and the whole thing is very light and handy, and owing to the narrow end can be used in awkward places.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

British Steel Makers and the Cartel.

The iron and steel markets appear to be anxiously awaiting the result of the meeting between the representatives of the British Iron and Steel Federation and the European Steel Cartel. The general impression seems to be that an arrangement of at least a temporary character regarding the British market will be made whilst negotiations are proceeded with regarding the export markets. The Continental makers seem convinced that they will be able to get a quota for Great Britain of 750,000 tons per annum, but on the British side there seems to be no idea that the last offer of 643,000 tons will be greatly exceeded. The members of the Cartel also seem to be under the impression that any arrangement with the British may include a reduction in the duties from the high levels to which they have been recently advanced, or at least a revision in favour of Cartel countries. This, however, would open up prospects of all kinds of complications. Lately, the Continental steel makers have been busy adjusting some of their internal differences, and the Saar question appears to have been settled for the time being by a mutual arrangement between France and Germany by which each country will give the other a yearly import quota. It is understood that Germany will take 50,000 tons of bars and joists, whilst the French will import plates, bars, and joists approximately to the same tonnage. The German group has also been given an additional export quota on account of the Saar. In one sense, therefore, it will be a more united Cartel which will meet the Federation on April 16th than when the two parties met at Cannes. Whilst the market believes that an agreement will follow next week's meeting, fears are expressed that another breakdown of the negotiations would result in a period of severe price cutting. In this event, it is suggested that the devaluation of the Belga would prove of great assistance to the Belgian steel industry, notwithstanding official statements that the official Cartel prices must be adhered to. The arrangements between the Continental suppliers and British consumers by which the increase in the duty has been shared on condition that unexecuted balances of contracts in the hands of the Continental steel works are not cancelled appears to be working satisfactorily. Lately, however, it is said that the arrangement has been extended to cover transactions of a more recent date, to which originally it was not, strictly speaking, intended to apply.

Pig Iron.

If there has been no noticeable pressure of demand for foundry pig iron, business has moved on steady lines. In most districts the requirements of the light foundries, particularly those which specialise in producing castings for the building trades, have been disappointing. Recently, however, the inquiry from these foundries has increased, and there are prospects that their requirements will expand. This seems the more likely since there is no indication that building developments are slackening. It is reported from the North-East Coast that a fair inquiry has been in circulation lately and deliveries to Scottish as well as to local consumers have been on a satisfactory scale. The shipments from the Tyne in March showed an improvement on the previous month, the figures being 14,357 tons, compared with 10,600 tons in February. Of this quantity foreign shipments totalled only 3485 tons, compared with 4027 tons in February. It is doubtful if home consumption is more than maintained at the level ruling in March, but a few contracts which expired have been renewed. Generally speaking, however, there is a tendency on the part of consumers to cover only their visible requirements and to avoid entering into long-distance commitments. This may indicate some want of confidence in the future, or it may be that with prices so firmly established at official levels users feel safe in adopting a hand-to-mouth policy. A fair amount of business has been transacted in Midland irons, but the general tone of the market has been lethargic. Practically all the large consumers in this district are said to have covered their requirements up to the end of June, and apparently there has been no need for them to buy supplementary tonnages for some time. In fact, it looks as though at the present rate of consumption there will be undelivered balances to work off at the end of the second quarter. In Scotland there is a steady passage of pig iron to the consuming industries, but some of the smaller jobbing foundries are not well off for work. On the whole, however, the Scottish producers have not much to complain about. The steel works hematite requirements do not seem to be growing; but one of the more cheerful features is that South Wales consumers have been taking larger quantities of late. On the East Coast two hematite furnaces at the Ayrsome Ironworks of Gjers, Mills and Co., Ltd., have been damped down for relining.

The Midlands and South Wales.

The market in the Midlands appears to have quickly adjusted itself to the conditions resulting from the higher import duties, and there has been a substantial amount of buying. The re-rolling industry in this district has benefited to a considerable extent, and apparently expects to enjoy a large measure of prosperity under the new conditions. Practically all the Midland re-rolling firms are in the Association of Rollers and Re-rollers, so that their supplies of raw material are assured. They expect now that they will be relieved from the difficulties created by Continental competition in the home market. With the quotation for small bars fixed at £8 12s. by the associated British firms and Continental bars selling at £7 1s. 6d. d/d before the duties were advanced, there was great temptation to consumers to satisfy at least part of their requirements from foreign sources. An effectual stop, however, appears to have been put to business in Continental merchant bars in the Midlands unless some drastic change in price conditions takes place, and this seems unlikely, notwithstanding the devaluation of the Belga. The position with regard to steel strip is similar, and it is understood that several thousand tons of both bars and strip have yet to be delivered against contracts. The demand for structural material has also increased this week, and some firms which were not in the British Steel Makers' Rebate Scheme are understood to have applied for admission and will in future buy British steel. Generally speaking, the constructional engineering concerns are busy and have lately shown more disposition to place forward contracts. There has been some substantial buying of colliery steel which may have been in anticipation of the increase in the Midland price for light arches from £7 15s. to £8. No alteration, however, was made in the quotation for heavy arches, which was kept at £8 15s. A steady business has been done lately in bright drawn steel bars, the official price for which has been held at £13 10s. for some time, although quotations below that have been obtainable from non-associated firms. The market in South Wales remains quiet on the whole, largely as a result of the restricted demand for tinplates. The British works are still confining their attention to certain markets by arrangement with the other parties to the International Tin-plate Scheme in order that the latter may fill their quotas. It is not expected that these allotments will be filled before June, so that a period of limited business must be looked for.

The North-East Coast and Yorkshire.

The demand for finished steel has not yet responded to the stimulating effect of the higher duties, probably owing to the devaluation of the belga, which has unsettled the market. So far, the arrangement by which the Belgian steel makers will continue to quote the Cartel official prices has prevented any cheap offers being made as a result of the depreciation in the currency; but consumers naturally feel that it is better to maintain a watchful attitude for a time. The steel works on the North-East Coast are well employed, and production is at a high rate; but the time is gradually approaching when unless new business comes forward in volume the outlook will not be free from anxiety. In March there was a slight decline in the shipments of manufactured iron and steel, the total being 33,537 tons, compared with 35,664 tons in February. During the first fortnight of April export business has been distinctly quiet and the general home trade demand has suffered from the circumstances previously referred to. Large orders for railway material are in hand, and will keep the works busy for some time. The demand for structural material also remains at a satisfactory level. The constructional engineers on the North-East Coast not only have large orders in hand, but there is also a considerable volume of new work in prospect. Business in sheets fails to increase. The demand from overseas markets remains disappointing, and the requirements of home consumers have shown few signs of expansion. The plate mills are moderately well occupied, but there is little fresh business in sight. The production of semis on the North-East Coast is at a high rate, and although few orders have been placed this week good deliveries have been made and the works are better placed than for several months past. The Yorkshire steel industry is operating in some cases almost at capacity. The production in Sheffield in particular is satisfactory, although there has been some relaxation in the demand for acid steel. Business in basic steel has been active for a long time, and the demand will probably be increased by the new duties once the market has become accustomed to the changed conditions. The requirements of the tool makers are large, although they are reported to be somewhat less than at this time last year. Probably one of the best features is the strong demand for stainless steel. Although there was some slackening in trade in this department a few weeks ago the business placed since has more than made this up.

Current Business.

An order for 264 complete axle-boxes for the New Zealand railways has been placed with British Timken, Ltd., of Birmingham. The Polish Government has placed an order with J. Samuel White and Co., Ltd., of Cowes, I.O.W., for the construction of two torpedo-boat destroyers. The British Thomson-Houston Company, Ltd., has obtained an order for eighteen mercury arc rectifiers for the extension of the electrification of the South African Railways. It is understood that this is the largest single contract ever placed for this type of rectifiers. It is announced that Vickers-Armstrongs, Ltd., has purchased the ship-repairing yard and dry dock business of Palmers Hebburn Company, Ltd. Hughes Bolckow Shipbreaking Company, Ltd., of Blythe, have bought the Danish steamer "Botnia," of 1326 tons, for breaking up. The South Durham Steel and Iron Company, Ltd., Middlesbrough, propose to extend their sheet and plate plant if arrangements can be made with the local corporation for the substitution of a new road for an old right of way adjoining the company's works. The Department of Overseas Trade announces that the following contracts are open for tender:—Indian Stores Department: Screw couplings (Simla, April 30th); aeroplane hangars (Simla, May 13th); an electrically driven vertical-spindle, tubewell, turbine pumping set, capable of delivering 30,000 Imperial gallons per hour against a total head of 148ft., complete with sluice valve, reflux valve, &c. (Simla, April 24th). Egypt, Public Works Department: 230 water meters for Giza and 58 meters for Helwan Tanzim Stores (Cairo, May 18th). Survey General of Egypt: 51 tons of angle irons, 50 cm. long, and 19 tons, 25 cm. long, pointed at one end and drilled at both ends (Egypt, May 25th); Minister of Finance: about 4500 tons of light and heavy rails, new or second-hand (Giza, June 15th); Minister of the Interior: 2600 lineal metres of 150 mm. diameter, 850 m. of 100 mm. diameter, and 150 m. of 80 mm. diameter centrifugally cast pipes, with specials and fittings (Cairo, May 4th); Minister of Public Works, Cairo: Pure tin for soldering, bronze, lead, white metal, lead pipes and galvanised iron pipes, 1in., 1¼in., 1½in., and 2in. internal diameter (Egypt, May 4th). Argentine State Railways Administration: 322,575 kilos. of mild steel bars, plates, angles, &c., various sizes (Buenos Aires, April 24th).

Copper.

The electrolytic copper market has been under the influence of the agreement between the copper producers to restrict production, and there has been heavy buying in practically all markets with the result that the price has advanced to 7.70c. c.i.f., or about £35 10s. The demand from European countries has been active, but transactions with Germany and Italy have been limited by the difficulties of arranging payment owing to Government restrictions upon remitting money. In America consumers have bought with some freedom, but the official price has been kept at 9c. delivered. Some fresh particulars which have reached Europe of the international arrangement between the producers are to the effect that the limitation of American exports to 8000 tons per month will only be maintained so long as the price in Europe does not rise above the equivalent of 9c. At the same time, it is reported that an attempt is to be made to advance the American fixed price to 10c. Probably the price on this side of the Atlantic would have risen more abruptly were it not that consignments of copper have been, and are being, shipped by the American companies with the intention apparently of sending some of their stocks abroad before the restriction scheme comes into force. This has had the effect of preventing a too rapid advance in values, although later on it may result in complicating the working of the scheme. Reports from America are to the effect that the intention of the producers is to raise the price of copper in Europe to 8.50c. per lb. c.i.f., and naturally some uneasiness has been created amongst consumers who, in many cases, have taken steps to cover their forward requirements. The forward buying, however, has not been so heavy as was expected, probably because of the unsatisfactory financial position in many export markets. The London standard market has naturally reacted favourably to these conditions, and the price has gone above £31 15s., the highest point touched this year. There has been a considerable amount of speculative buying, but at the moment the bull account is not unwieldy.

The Tin Market.

The recent improvement in the tin market has been maintained and a more healthy tone has developed. Consumers in the United States have bought moderate quantities, and the buying has been spread over a longer period than has been the case with recent American movements, and this, together with the improved prospects of the large tin-consuming industries in that country, have encouraged the market to expect heavier purchases in the not distant future. Continental buyers also have shown more interest in the metal and, as consumers so frequently do, have bought when the price moved upwards. A feature of the position has been the heavy premiums which have been asked for particular brands. For Banca up to £6 over the standard price has been demanded, and the premium on Straits tin has been anything between £5 and £6. This has been due to the comparatively high prices which have ruled in the East for some time, and which have been well above London parity. Considerable interest has been expressed as to the effect which the devaluation of the Belga will have upon the position of the Belgian Congo tin-mining industry, and it is suggested that it will be possible now for the mines to develop some of the poorer deposits. The conditions in the tin market have not changed in essentials and the market is still firmly in the grip of the international control. It would appear, however, that the various pools which have been operating in this market have not played such an active part since so much publicity was accorded them a few weeks ago. There is still a heavy backwardation; which has declined, however, from over £4 to about £3.

Lead and Spelter.

Interest in the lead market has been chiefly centred upon the scheme which is to be placed before the Import Duties Advisory Committee in substitution for the one which was recently rejected by that body. The original scheme would have provided for an import duty to be graded according to the price up to £13 per ton. The intention apparently was to peg the price at about that figure which would have been satisfactory alike to producers and consumers. The new scheme which has been prepared is reported to have been approved in principle by the Committee, and has also been referred to various trading organisations which are interested in the matter. No details of the plan have been made public. There is still a good demand for lead from consumers in this country, but buying in anticipation of the changes which would have ensued had the former plan been adopted was on a very heavy scale and may result in rather less activity for a time. . . . Similar conditions have ruled in the spelter market, and the price has shown an easier tendency. The arrivals during March were not heavy, and the impression seems to prevail that the world's stocks are showing a tendency to decline.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 8 6	3 2 0
No. 1	3 9 0	3 2 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 7 6	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 12 6	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 7 6	—
N.W. Coast—		
Hematite Mixed Nos.	3 12 6 d/d Glasgow 4 0 6 „ Sheffield 4 5 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	7 5 0 to 7 15 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ 5/16in.	9 5 0	8 0 0
„ ⅜in.	9 10 0	8 5 0
„ 7/16in.	9 15 0	8 10 0
„ ½in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0 to 8 5 0

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ 5/16in.	9 0 0	8 0 0
„ ⅜in.	9 5 0	8 5 0
„ 7/16in.	9 10 0	8 10 0
„ ½in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ 5/16in.	9 2 6	8 0 0
„ ⅜in.	9 7 6	8 5 0
„ 7/16in.	9 12 6	8 10 0
„ ½in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ 5/16in.	9 5 0	9 7 6
„ ⅜in.	9 10 0	9 12 6
„ 7/16in.	9 15 0	9 17 6
„ ½in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 0 0	8 15 0
14-G. to 20-G., d/d	10 5 0	9 0 0
21-G. to 24-G., d/d	10 10 0	9 5 0
25-G. to 27-G., d/d	11 2 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £16 12s. 6d., c.i.f. duty paid India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.

20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2 to 19/2.

Tin-plate Bars, d/d South Wales Works, £5 7s. 6d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 tons	5 15 0
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 10 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 10 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£24 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9¾d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/– to 5/6d. per lb.	

NON-FERROUS METALS.

Official Prices, April 10th.

Copper—		
Cash	£31 10 0 to £31 11 3	
Three months	£31 18 9 to £32 0 0	
Electrolytic	£35 0 0 to £35 10 0	
Best Selected Ingots, d/d Birmingham	£35 15 0	
Sheets, Hot Rolled	£60 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	9¾d.	9¾d.
„ Brazed (basis)	9¾d.	9¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £30 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9d.	9d.
„ Brazed	11d.	11¼d.
Tin—		
Cash	£223 5 0 to £223 15 0	
Three months	£219 15 0 to £220 0 0	
Lead	£12 1 3 to £12 6 3	
Spelter	£12 16 3 to £13 1 3	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
f.o.b. Grangemouth—Navigation Unscreened	13/– to 13/6
„ Glasgow–Ell	16/6
„ „ Splint	17/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/– to 14/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/3 to 14/–
Unscreened Navigation	12/6 to 13/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/6 to 13/9
Secondary Steam	13/– to 13/3

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	15/– to 17/6
Northumberland, Newcastle—	
Blyth Best	14/3 to 14/6
„ Second	13/3
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/6
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	24/– to 26/–
South Yorkshire Best	21/– to 23/–
South Yorkshire Seconds	17/6 to 19/–
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	13/6 to 14/–
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	24/– to 37/6
Furnace Coke	19/– to 21/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 22/6
Rubbly Culm	10/6 to 11/–
Steam Coals:	
Large	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

Manchester prices ½d. per gallon extra.

French Engineering Notes.

(From our own Correspondent in Paris.)

The Industrial Situation.

ONE reason for the hurried visit of the French Minister of Commerce to Brussels was a fear that the devaluation of the belga would have serious repercussions on the metallurgical and engineering industries in the Nord, and another reason was to prevent the belga from being linked up with sterling. The Minister appears to have succeeded in his mission. He did not go to Brussels under altogether favourable circumstances, for a strong feeling had been aroused there by allegations that the belga had been forced off its standard by the refusal of France to give increased trading facilities, as promised when the gold convention was signed, but everything points to the assumption that behind the agreement made by the French Minister and Monsieur Van Zeeland there is an understanding that reciprocal concessions will be accorded for trade expansion. The absence of such concessions so far has been the main cause of the trouble amongst the gold countries. The difficulty lies in giving preferential treatment without denouncing existing treaties. Monsieur Van Zeeland has stated that the agreement with France to the effect that exporters will not reduce prices to below the level of those obtaining before the devaluation of the belga will apply to other countries. In other words, the goods themselves will not be devalued, and there will be no increased competition, the only result being to give exporters bigger profits. Nothing further can be said until an opportunity is provided of seeing how the system works. Meanwhile, these currency uncertainties have had a depressing effect upon trade, and the only element of activity is afforded by the work being carried out for national defence. Engineering firms specialising in such work are well employed, and there is reported to be a good demand for special high duty machine tools for the State arsenals and factories. The decrease of unemployment figures might be taken as evidence of more industrial activity, but this improvement is attributed to a larger number of men being engaged on work of national defence and also on the public relief works which are being extended, though less rapidly than had been expected. The unemployment figures are also reduced by the elimination of foreign workers whose permits are withdrawn, except in special cases. Work is promised in the future as the result of the recommendation of the Imperial Economic Commission to spend 11,200 million francs over a period of fifteen years for colonial undertakings, and it also favours the construction of the Trans-Saharan Railway, though it abstains from making any recommendation for an enterprise which is outside the scope of its inquiry. The methods of financing these colonial undertakings do not permit of any large sums being immediately available. All the public services could put in hand a vast amount of useful work if the necessity for pursuing a national policy of strict financial economy did not deprive them of the means of carrying it out.

Manufacturing Costs.

Before the agreement was entered into with Belgium to stabilise the prices of goods imported into France, the fall of the belga brought home to the French the widening gap between their own prices and those of other countries which would necessarily be accentuated by a further dislocation of the gold group, unless the arrangements now being made should provide an effective compromise. Their idea that devalued currencies must be followed by a corresponding inflation of internal values, such as happened in this country, has so far not been realised abroad, and consequently industries that do little for export continue to oppose measures that aim at facilitating foreign trade at their expense, while others urge that their only hope of safety lies in being relieved of taxation. Efforts are being made to do this in the case of exporting industries, and for several months past motor car manufacturers have benefited from the suppression of the turnover tax on cars exported, the relief thus accorded being equivalent to a bounty of 1·9f. per kilogramme. A scheme is now in preparation to replace existing taxes on the motor car industry by one tax, which will doubtlessly be arranged to give manufacturers the relief they require. If successful, it may be extended to other industries, and thereby help to bring about a deflation of prices which is one of the chief aims of the Government's economic policy. There is, however, a limit to taxation relief.

The Paris Exhibition.

In whatever way the industrial situation is relieved, it should be accelerated by the necessity of preparing for the International Exhibition in Paris in 1937, which must depend for its success upon favourable economic conditions. In present circumstances it would probably be a failure, in the same way that the Brussels Exhibition would have failed to attract visitors from many countries if Belgium had not devalued her currency. Measures are being taken to prevent a speculative inflation of internal prices, and, in view of what had already been done before the deflation, costs in Belgium should now be somewhere near the level of those in sterling countries. The same levelling of prices must be achieved to ensure the complete success of the Paris Exhibition which is regarded as of great importance for essentially national industries depending upon international exchanges, and it is hoped to make the exhibition a manifestation of a new era of prosperity following upon an adjustment of currencies and a provision for trade facilities that will be inevitable when the political outlook becomes more settled. Therefore, so far as this country is concerned, every effort will be made to bring about a return to normal trade conditions that may involve some sacrifice all round for the common good, but those efforts can only begin to produce effect when there is an international standard of values and internal values are adjusted to them. Meanwhile, work has started upon the Exhibition with a widening of the Pont d'Iena, and in the course of the next few months other preparatory operations will be well in hand, including the construction of a bridge, two permanent palaces on opposite banks of the Seine to be connected by another light bridge, and the carrying out of works in Paris that will give employment and require a large amount of material.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator printed are in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

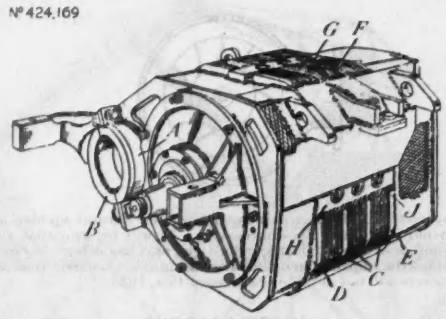
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

424,169. August 30th, 1934.—DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

An object of this invention is to provide a simple fabricated dynamo-electric machine construction which is particularly adapted for mounting on a shaft, such as an axle of a railway car or other vehicle. The stationary member includes a channel-shaped supporting member and bearing housing A extending substantially the entire length of the stationary member. The supporting member carries a bearing B at either end for mounting the motor on an axle or shaft, such as the axle of a vehicle. Laminations C are clamped between end plates D

Nº 424,169



and E, and plates F and G are interspersed or interleaved in the laminations. These plates are then welded to the supporting member and secured together to provide a rigid construction by tie bars H, which fit in notches in the laminations C, and the plates, and which are welded along their edges J to the laminations and the plates. The clamping pressure is then released and the laminations are firmly secured to the supporting member. The laminations are notched to conform to the supporting member, so that the supporting member forms part of the magnetic circuit of the motor. There are eleven other illustrations relating to other constructional details.—*February 15th*, 1935.

424,483. October 8th, 1934.—EXCITING ARRANGEMENTS FOR DYNAMO-ELECTRIC MACHINES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

The invention relates to the excitation arrangements for the electric generator of a petrol-electric vehicle. In such cases it is known to arrange the excitation so that throughout the working range of the generator it has a practically hyperbolic voltage current characteristic. The main generator A has a shunt field B with which the exciter machine C is connected in series. The exciter is preferably mounted on the shaft of the main generator

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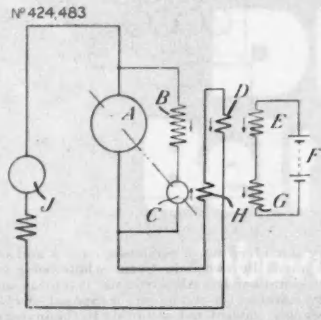

or driven at a speed proportional thereto. The generator A has also the compound winding D and may have a separate field winding E which can be inserted either permanently or temporarily. This separate exciting field winding E can be fed by any current source which is approximately constant; for example, by a battery F. The exciter machine has a field winding G, which is energised from a practically constant current source, such as the battery F, and can be connected in series or parallel with the winding E. The exciter has, in addition, a differential field winding H in series with the main generator. A driving motor for the vehicle is represented at J.—*February 21st*, 1935.

TELEGRAPHS AND TELEPHONES.

423,990. July 30th, 1934.—THERMIONIC GENERATORS, N. V. Philips' Gloeilampenfabrieken, of Emmasingel, Eindhoven, North-Brabant, The Netherlands.

The invention has for its purpose to provide an arrangement for producing oscillations having a higher frequency than was hitherto possible in a tube with two or more anodes surrounding a cathode. In Fig. 1 both of the anodes A and B are represented in section within a tube which may or may not be exhausted. They surround an incandescent cathode C which extends normal to the plane of drawing. The field winding, which is fed by rectified alternating current or direct current, and is arranged in such a manner that the lines of force extend parallel with the cathode, is not represented in the drawing. An oscillatory circuit consisting of an inductance D and a condenser E is provided between the anodes. If it be assumed that the generator is oscillating and that at a given moment the voltage set up at the anode A increases, whereas the voltage set up at the anode B decreases, then the electrons will substantially be attracted by the anode A. However, by adjusting the intensity of the magnetic field to the right value, the electrons take a curved path as shown in dotted lines. Owing to this the electrons attracted by the anode A will reach the anode B, thus contributing to the decrease of the voltage of the anode B. This continues until after a half-cycle of the oscillations in the circuit E, D, the polarity of the anodes A and H reverses, and the voltage set up at the anode B increases, whereas that set up at the anode A decreases. The electrons will now take such a path that they impinge on the anode A and tend to promote the decrease of the voltage of the anode A. The arrangement, according to the invention, comprises, however, at least four anodes

Nº 423,990

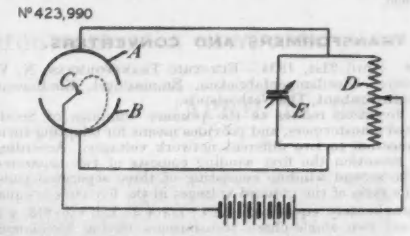

Fig 1

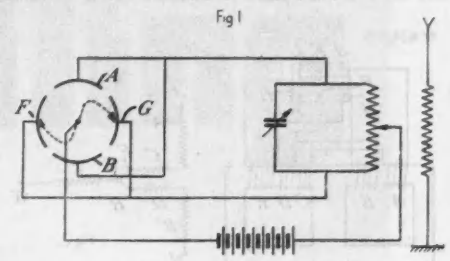

Fig 2

which are alternately electrically connected together, as shown in Fig. 2. A circuit which is tuned to the generated frequency and preferably consists of an evenly distributed inductance and a capacity, is provided between the pair of anodes A, B and the pair. F G.—*February 12th*, 1935.

TRANSMISSION OF POWER.

424,474. July 19th, 1934.—ELECTRIC POWER CABLE SYSTEMS FOR THE UNDERGROUND TRANSMISSION OF ELECTRICAL ENERGY, The Okonite-Callender Cable Company, Incorporated, of Paterson, New Jersey, U.S.A.

This invention is concerned with electric cable systems in which the cable and an insulating liquid are contained in a pipe. The cable may consist of one or more insulated but unsheathed conductors and the liquid may be an insulating oil which is under pressure and in which the insulated conductor (or conductors) is submerged. An object of the invention is to provide a relatively cheap construction by means of which a leak of liquid in the pipe containing the cable can be easily and quickly located. The unsheathed conductors A of a multi-conductor cable are laid in a pipe B which is filled with a liquid insulating material C. This material may be an insulating oil and it may be under a relatively high pressure. The pipe is laid on a gutter structure composed of a number of tiles or slabs D. Each tile has a central channel E and the tiles when laid provide a con-

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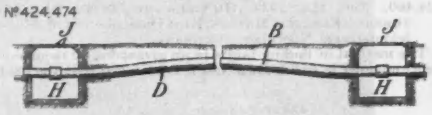

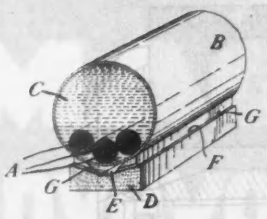

tinuous gutter below the pipe. The sides of each tile E are cut back to provide the gutters F, and at intervals holes G are bored through the tile into the central gutter E so that any escaping oil flowing down the sides of the pipe B will seep into the central gutter E. In the example the gutter structure has an undulating contour and at the various points of low level sumps are provided, which are located in manholes H. These sumps collect any oil which escapes from the pipe B and which will flow down the gutter or channels E and F under gravity. The sumps are provided with covers J and are made readily accessible from the ground level so that they can be inspected regularly. The presence of oil in one of these sumps will indicate that a leak exists in the pipe B in the length between the sump and the adjacent high point of the line at one side or the other of the sump. If the trench in which the cable is to be installed is initially level it will be dug away so as to give it a slightly sloped or inclined surface in order to provide an undulating supporting surface for the gutter structure.—*February 21st*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

424,043. June 11th, 1934.—TRUNNIONS FOR LADLES, Vereinigte Stahlwerke Aktiengesellschaft, 67, Breitestrasse, Düsseldorf, Germany.

The object of this invention is to minimise the wear of the

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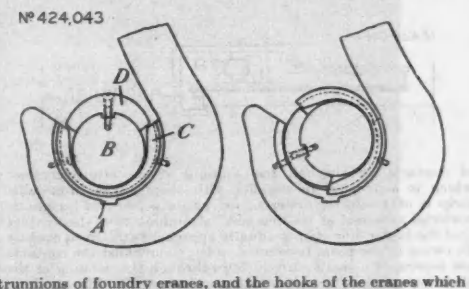


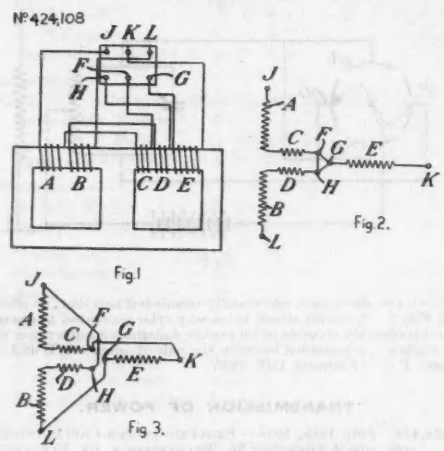
trunnions of foundry cranes, and the hooks of the cranes which manipulate them, caused by the accidental splashing of slag between the two moving parts. The interior of the hook is provided with a renewable wearing piece A, which is keyed

in position. Between it and the trunnion B there is placed a loose saddle piece C, and on the top of the cover there is fixed a cover D. When the ladle is tipped the saddle piece is pushed round by the cover D, which incidentally prevents the ingress of grains of slag. The arrangement has the advantage that the saddle piece can be very easily renewed on the spot.—*February 13th*, 1935.

TRANSFORMERS AND CONVERTERS.

424,108. April 21st, 1934.—ELECTRIC TRANSFORMERS, N. V. Philips' Gloeilampenfabrieken, Emmasingel, Eindhoven, North-Brabant, The Netherlands.

The invention relates to the primary windings of Scott-connected transformers, and provides means for adapting them for connection to two different network voltages. According to the invention the first winding consists of two separated coils, the second winding consisting of three separated coils, while the ratio of the induced voltages in the five coils is equal or approximately equal to: $1 : 1 : 1/3\sqrt{3} : 1/3\sqrt{3} : 2/3\sqrt{3}$. There are two single-phase transformers having a common

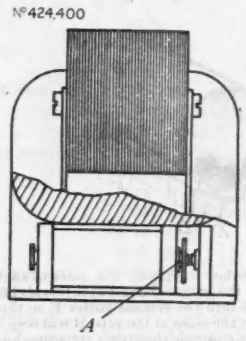


yoke. For the sake of convenience only the primary windings are represented. One of the windings is divided into two coils A and B, which have equal turns, the other winding consisting of three coils C, D, and E, of which the first-mentioned two coils have equal turns, whereas the number of turns of the third coil is double that of the windings C and D. The ratio of the induced voltages in the coils A and C is $1 : 1/3\sqrt{3}$. The coils A, C and B, D, respectively, are connected in series in the manner shown in the drawing. The free ends of the coils are connected to terminals F, G, H, J, K, and L. The transformer thus arranged can be used for two different network voltages, and the connections for the higher and lower voltage supplies are shown in Figs 2 and 3 respectively.—*February 11th*, 1935.

MEASURING AND TESTING INSTRUMENTS.

424,400. July 31st, 1934.—DEVICES FOR TESTING THE ARMATURES OF ELECTRIC MOTORS, Kurt Dutschke, of 6, Schluesselfelderstrasse Nuernberg, Germany.

The method of finding faults in an armature by means of an electromagnet is well known, but it is essential that the magnet

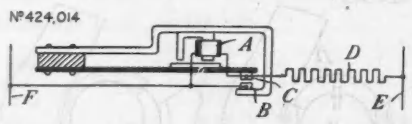


shou l be energised with A.C. According to the invention, however, an interrupter A is provided to enable the testing magnet to be used on a D.C. circuit. The interrupter is, of course, connected in circuit with the coil and has the effect of producing an interrupted current capable of inducing currents in short-circuited armature coils.—*February 20th*, 1935.

LIGHTING AND HEATING.

424,014. September 12th, 1933.—THERMALLY OPERATED ELECTRIC SWITCHES, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.*

According to this invention a magnetic auxiliary force is utilised to generate a preliminary pressure directed against the closing of the contacts of thermostatically operated switches. the force being extinguished as soon as the contact is made, thereby increasing the contact pressure. The electro-magnet A is connected with the contacts B and C. A heating resistance D has one end connected to the supply conductor E, and its other end connected to the return conductor F over the pair

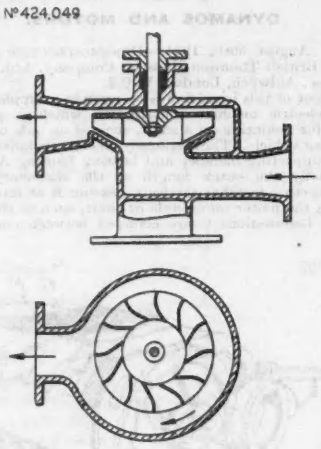


of contacts, or through the winding of the electro-magnet which is connected in parallel with them. The bi-metallic strip is of magnetic material, or carries a piece of magnetic material attached at its free end. Assuming that the contact C of the bi-metallic strip gradually approaches the fixed contact B, owing to the room becoming cooler, then whilst the contacts are separated a small current flows through the winding of the electro-magnet A and the heating resistance D. The winding, however, is of such high resistance that it has practically no heating effect on the resistance D. Energisation of the electro-magnet causes attraction of the strip and thus opposes the closing movement of its contact C. As soon as the contact C, overcoming the magnetic restraint, engages contact B, the winding of the magnet becomes short-circuited and the pressure on the contacts thereby increases. As soon as the thermal strip has separated the contacts, owing to the room becoming warmer, the electro-magnet is again energised and tends to separate the contacts still further.—*February 13th*, 1935.

PUMPING AND BLOWING MACHINERY.

424,049. September 10th, 1934.—CENTRIFUGAL PUMPS, *H. G. C. Fairweather, 65, Chancery-lane, London, W.C.2.*

This specification describes a fairly normal centrifugal pump for assisting the circulation through hot water heat-

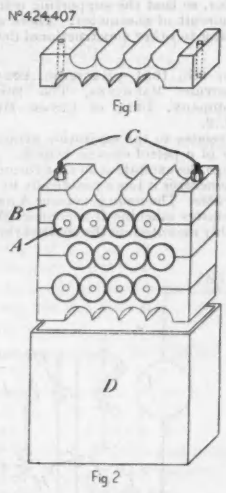


ing systems, which gives a free passage for natural circulation, should the pump be unnecessary. It will be seen that the pump is of the vertical spindle type, and has a big clearance round the impeller, and that the casing is so designed that air pockets will not develop.—*February 13th*, 1935.

MISCELLANEOUS.

424,407. October 17th, 1934.—ELECTRICAL CONDENSERS, Stanley Lingard, of 103, Berkeley Court, London, N.W.1.

This invention applies to electrical condensers, particularly those consisting of a number of coils arranged in a common container, and has for its object a rapid and rigid assembly of such coils. The drawing Fig. 1 illustrates a separating member adapted to hold a number of cylindrical coils. Fig. 2 illustrates



a completely assembled set of condenser coils A and separating members B joined by two bolts C, the whole being suited for fitting into a container D. Although the invention appears to be especially suitable for condensers composed of cylinderical coils, a condenser constructed according to the invention is not limited to such a shape of coils.—*February 20th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Savoy-place, W.C.2. Address by the President, Prof. W. M. Thornton. 6.30 for 7 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Extra general meeting. Discussion, "Aerodynamical Research and Hydraulic Practice," Mr. A. Fage. 6 p.m.

INST. OF SANITARY ENGINEERS.—At Caxton Hall, S.W.1. "The Manufacture of Concrete and Stoneware Pipes and their Uses," Mr. Cyril Poole. 6 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. "Art and Industry in Scandinavia," Mr. C. H. G. Aston. 7.30 p.m.

TO-DAY TO THURSDAY, APRIL 18TH.

IDEAL HOME EXHIBITION.—Olympia, W. Open daily.

MONDAY, APRIL 15TH.

ENGINEERS' GERMAN CIRCLE.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "The New Bridge over the Little Belt," Dr. Ing. e.h.o. Erlinghagen. 5.15 for 6 p.m.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Queen's University, Belfast. "The Preparation of Estimates for Public Works," Mr. F. C. Fforde. 6.30 p.m.

INST. OF MECHANICAL ENGINEERS: GRADUATES.—Storey's-gate, Westminster, S.W.1. "Compressed Gas as a Locomotive Fuel," Mr. J. C. Paterson; "The Treatment of Water for Locomotives," Mr. A. D. Smalley; "The Caprotti Valve Gear for Locomotives," Mr. R. Purdie. Discussion. 6,45 p.m.

ROYAL AERONAUTICAL SOC.—At Inst. of Electrical Engineers, Savoy-place, W.C.2. "Commercial Aircraft," Captain C. de Havilland. 6.30 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Part Played by Rubber in Transport," Mr. Colin Macbeth. 8 p.m.

TUESDAY, APRIL 16TH.

BRITISH ASSOC. OF REFRIGERATION.—At Inst. of Marine Engineers, 85–88, Minories, E.C.3. Symposium of papers on Insulation. "Some Notes on Refrigerating Insulation and Insulating Materials," Dr. Ezer Griffiths, F.R.S.; "Modern Refrigerating Insulation Practice," Mr. G. Yate Pitts; "Progress in Refrigerating Insulation Construction," Mr. W. H. Partridge. 6.30 p.m.

INST. OF CIVIL ENGINEERS.—Great George-street, S.W.1. Discussion, "Billingham Branch Bridge," Messrs. W. P. Haldane and G. Roberts; "Tees (Newport) Bridge, Middlesbrough," Messrs. J. A. K. Hamilton and John Tudor Graves. 6 p.m.

INST. OF ELECTRICAL ENGINEERS: S. MIDLAND STUDENTS.—James Watt Memorial Inst., Birmingham. Annual general meeting. Paper, "Load Factor," Mr. T. G. Proctor. 7 p.m.

WEDNESDAY, APRIL 17TH.

INST. OF CIVIL ENGINEERS: STUDENTS.—Great George-street, S.W.1. Annual general meeting. 6.30 p.m.

INST. OF LOCOMOTIVE ENGINEERS.—At Inst. of Mechanical Engineers, Storey's-gate, S.W.1. "Locomotive Testing Plants (with Special Reference to the Testing Plant at Vitry)," Monsieur Pierre Place. Film of working of plant at Vitry. 6 p.m.

INST. OF STRUCTURAL ENGINEERS: SCOTTISH BRANCH.—129, Bath-street, Glasgow. Fourth annual general meeting. Paper, "Some Aspects of the Influences of the Aggregates on Concrete Strength," Mr. W. Hunter. 7 p.m.

ROYAL MICROSCOPICAL SOC.—B.M.A. House, Tavistock-square, London, W.C.1. Meeting. 5 p.m. for 5.30 p.m.

SOC. OF CHEMICAL INDUSTRY.—At Federation of British Industries, 21, Tothill-street, S.W.1. Joint meeting with Inst. of Chemical Engineers. Symposium, "Heat Transfer in the Food Industry." Afternoon, 3.30 p.m.; evening, 6 p.m.

THURSDAY, APRIL 18TH.

INST. OF MARINE ENGINEERS.—85/88, The Minories, E.C.3. Junior Section debate, "Should the Marine Engineer have a University Training?" For, Mr. K. P. Harman; against, Mr. H. R. Tyrrell. 7 p.m.

INST. OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—At Hotel Metropole, Leeds. Annual general meeting. Paper, "Piling Foundations," Mr. Gower B. R. Pimm. 7 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS: TEES-SIDE BRANCH.—At Cleveland Scientific and Technical Inst., Corporation-road, Middlesbrough. "Production in Engineering Works," Mr. T. C. Green. 7.30 p.m.

FRIDAY, APRIL 26TH.

INST. OF ELECTRICAL ENGINEERS: LONDON STUDENTS.—Savoy-place, W.C.2. Informal discussion. 6.30 for 7 p.m.

JUNIOR INST. OF ENGINEERS.—39, Victoria-street, S.W.1. Informal meeting. General discussion on "Engineering Topics." 7.30 p.m.

NORTH-EAST COAST INST. OF ENGINEERS AND SHIPBUILDERS.—At Mining Inst., Newcastle-upon-Tyne. "Ship Collisions," Mr. H. E. J. Camps. 6 p.m.

MONDAY, APRIL 29TH.

INST. OF CIVIL ENGINEERS: BELFAST AND DISTRICT ASSOC.—Queen's University, Belfast. Annual general meeting. 6.30 p.m.

SOC. OF ENGINEERS.—At the Geological Society, Burlington House, W.1. "Modern Methods of Engineering Training," Dr. Herbert Schofield. 5.30 for 6 p.m.

TUESDAY, APRIL 30TH.

INST. OF FUEL.—At Chemical Soc., Burlington House, W.1. "Paper dealing with "The Production of Comparatively Ash-free Coal," M. Maurice F. Bertrand. 6 p.m.

FRIDAY, MAY 3RD.

INST. OF ELECTRICAL ENGINEERS: N.-EASTERN STUDENTS.—Annual general meeting.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W.1. Discussion, "Progress in Design and Application of the Lysholm-Smith Torque Converter, with Special Reference to the Development in England," Dr. H. F. Haworth and A. Lysholm; "Voith Turbo Transmissions," Dr.-Ing. W. Hahn, translated by Mr. H. Sinclair. 6 p.m.

RAILWAY CLUB.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Railways in the Air," Mr. J. W. C. Logan. 7.30 p.m.

WEDNESDAY, MAY 8TH.

INST. OF METALS.—At the Inst. of Mechanical Engineers, Storey's-gate, S.W.1. Twenty-fifth annual May Lecture. "Atomic Arrangements in Metals and Alloys," Prof. W. L. Bragg, F.R.S. 8 p.m.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "Canals," Mr. W. H. Curtis. 8 p.m.

WEDNESDAY, MAY 8TH, TO SATURDAY, MAY 11TH.

INST. OF STRUCTURAL ENGINEERS.—Institution Conference in London.

FRIDAY, MAY 10TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—In Hall of the School of Economics and Commerce, Bell-street, Dundee. The Faraday Lecture, "Electricity in the Life of To-day," Prof. E. W. Marchant. 7.30 p.m.

INST. OF MECHANICAL ENGINEERS.—Storey's-gate, S.W.1. Informal meeting. Mr. John Holloway will introduce discussion on "Machine Tools: Twenty-five Years' Development Demonstrated at the Recent Machine Tools Exhibition." 7 p.m.

SATURDAY, MAY 11TH.

INST. OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Excursion from Dundee to Taymouth Castle Hotel *viâ* Dunkeld and Aberfeldy. Leave Albert-square, Dundee, 9.15 a.m.

WEDNESDAY, MAY 15TH.

INST. OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Visit to Droitwich Broadcasting Station. 3 p.m.

THURSDAY, MAY 16TH.

ROYAL SOC. OF ARTS.—John-street, Adelphi, W.C.2. "The Evolution of the Industrial System in the Far East," Prof. A. F. Barker. The paper will be read by Prof. A. T. King. 8 p.m.

MONDAY TO FRIDAY, MAY 20TH TO 31ST.

BRITISH INDUSTRIES FAIR: ENGINEERING AND HARDWARE SECTIONS.—Castle Bromwich, Birmingham. Daily except Sunday.

WEDNESDAY, MAY 22ND.

INST. OF ELECTRICAL ENGINEERS: SOUTH MIDLAND CENTRE.—Visit to Droitwich Broadcasting Station. 3 p.m.